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A CONCEPT FOR THE MANAGEMENT
OF READINESS

Laurence D. Richards
Peter L. Eirich
Murray A. Geisler

January 1980

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PREFACE

This study was initiated at the request of the then Staff Director, now Deputy Assistant Secretary for Requirements, Resources and Analysis, Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics). Having read the LMI report series, "A Macro Analysis of DoD Logistics Systems," published in 1976-8 in three volumes, he concluded that its approach to policy-level logistics management contained elements of a promising approach to readiness management.

The focus of this initial study was limited to materiel readiness. We examined the F-4 aircraft system as a case study, and used it to illustrate our concept. We reviewed Office of the Secretary of Defense readiness documents, including materiel readiness reports to the Congress and catalogues of reporting systems, models, and exercises prepared by the Readiness Survey Subgroup of the DoD Readiness Management Steering Group. We interviewed many Military Service administrators and analysts concerned with readiness management and research, and read reports prepared in their offices.

We believe the report will be of use to the many people who are trying to respond to the growing concerns about the complex area of readiness management.

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We wish to acknowledge the individuals in the Military Departments who contributed their knowledge of the problem and their opinions about solving it. In particular, we thank Mr. Ray Cavender of the Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) for his guidance and critical review during the course of the study. Within LMI, Mr. John Abell provided valuable insights and suggestions.

EXECUTIVE SUMMARY

Defense budgets are generally presented in terms of force modernization, weapon system procurement, and readiness. During most of the 1970's, the emphasis seemed to be on the first two of those elements. In the past three years, the President and Congress have stressed the need for increased readiness, and that change has been reflected both in defense guidance and in the budgets.

In addition, the Secretary of Defense has initiated actions to improve the internal management mechanisms for achieving increased readiness. On November 2, 1977, he issued a memorandum establishing the DoD Readiness Management Steering Group to formulate a long-range program of readiness improvement. However, that Group has been relatively inactive, and little progress has been made in carrying out the management objectives of the Secretary's memorandum.

The complexity of the problems posed by readiness management has contributed to the lack of progress. The subject of defense readiness necessarily pervades all aspects of defense management and activity: it has both short and long term implications; it cuts across all force types and resources; it relates to many measurement systems and has both objective and subjective elements; and it is affected by all the factors of uncertainty encountered in defense planning.

Accepting the ubiquitous character of readiness, our findings have indicated that the improvement of its management must be conducted on a broad basis, including the use of standardized terminology and definitions; the incorporation of multiple measurement systems; and the development of suitable

methods for relating readiness to resource inputs, ranging over all force types and applicable resource categories. We have developed a taxonomy of readiness terminology and definitions for standard usage throughout the DoD. We have also formulated a concept for integrating the major components of a readiness management system including definitions, types of measures, reporting systems, resource allocation methods, and a management structure for achieving consistency in approach across the DoD.

We recognize that the formulation of a readiness management concept is only the beginning of a long range effort needed to satisfy the requirements of Congress and the Secretary of Defense. That effort will have to assess and fill the gaps in readiness reporting and data collection systems, models and methods of analysis, and readiness exercises and tests, to develop information required by DoD decision-makers for resource allocation and planning across applicable force types and budget categories.

Action can now be taken by the Secretary to provide a common basis and guidance for the further effort required. We have drafted and propose Secretary of Defense issuance of: 1) a DoD Directive establishing the DoD Readiness Management Program and 2) Memoranda setting forth a Glossary of Readiness-Related Terms and requiring the Designation of Readiness Offices.

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1. INTRODUCTION

BACKGROUND

In the FY78 Defense Authorization Act, Congress legislated a demanding DoD readiness reporting requirement. The last sentence of Section 812 of that Act summarizes the requirement: "The budget for the Department of Defense submitted to the Congress for fiscal year 1979 and subsequent fiscal years shall include data projecting the effect of the appropriations requested for materiel readiness requirements." Realizing that "to meet that requirement fully, we in the Defense Department would need to have readiness measurement and analysis capabilities that are well beyond the current state-of-the-art," the Secretary of Defense (SecDef), on November 2, 1977, established the DoD Readiness Management Steering Group (RMSG).

The Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) was designated Chairman of the RMSG, with the Assistant Secretary of Defense (Program Analysis and Evaluation) as Vice-Chairman. The RMSG was tasked to develop a comprehensive long-range plan that would:

- ensure that DoD has meaningful and consistent measures of force readiness and the factors contributing thereto, including both materiel and personnel readiness;
- provide for periodic measurement and reporting of that readiness as necessary;
- develop the analytic tools necessary to relate resource inputs to resulting readiness;
- provide for tracking and projection of resource inputs necessary for these analyses, including the relevant weapon system operating and support costs;
- identify and recommend mechanisms to improve DoD's control over the application of resources that influence force readiness; and

- identify any changes in Service management or organization that would enhance DoD's capability to assess and manage the readiness of its combat forces.

The RMSG is not responsible for systems that report the immediate readiness status of combat units to Operational Commanders; they are the responsibility of the Joint Chiefs of Staff (JCS). Rather, the focus is on improving the visibility of relationships between resources and readiness, a necessary step in making sound resource allocation decisions in the annual programming and budgeting process.

The long-range plan requested by the SecDef has not yet been prepared. It was in this context that the Logistics Management Institute (LMI) was tasked to study the readiness measurement and management problem and to develop a concept for the comprehensive readiness management system that appears essential for the long-range plan. The initial focus was to be on the materiel readiness aspect of the problem, with the scope progressively broadened in subsequent studies.

While the long-range plan has not yet been prepared, there have been numerous efforts undertaken within DoD to study the problem of developing the required capability. In the Planning and Programming Guidance of March 11, 1977, each Military Department was instructed to begin defining a course of action to accomplish the following:

- Define meaningful and measureable readiness indicators for the different combat unit types that are valid indicators of the units' ability to accomplish their combat missions.
- Define the hardware availability, reliability, and maintainability that must be attained in the field for each weapon system/equipment to meet acceptable levels of materiel readiness (normally, such standards should be consistent with the specifications/goals approved through the Defense System Acquisition Review Council process).
- Develop the capability to monitor actual hardware performance relative to those availability, reliability, and maintainability standards.

- Identify the logistics support resources, by function, which influence each of these parameters of hardware performance.

The RMSG has the responsibility for ensuring that consistency is maintained among the Services' efforts to develop this management capability. The Long-Range Readiness Working Group (LRRWG) was assigned the task of producing a plan to guide these efforts.

As a first step, the Readiness Survey Subgroup of the LRRWG conducted a survey of the existing and developing capability to measure, report, analyze, track, project, and manage readiness. The product was a set of readiness catalogs:

- Catalog of Readiness and Readiness-Related Terms and Definitions;
- Catalog of Readiness Data Collection and Reporting Systems;
- Catalog of Readiness Studies and Models; and
- Catalog of Readiness Exercises.

A review of these catalogs shows that there is no lack of effort within the Military Departments to address certain aspects of the readiness management problem. The multiplicity of approaches, however, presents a problem in itself. Hence, one of our aims is to investigate methodological and management structures for organizing, integrating, and filtering the ongoing work to maintain as high a level of consistency as possible.

ASPECTS OF THE READINESS MANAGEMENT PROBLEM

That the readiness management problem has remained elusive for so long is a sign that numerous and complex difficulties are involved. These difficulties include:

1. Inconsistent definitions of readiness both within and across the Services. This phenomenon is the result of a number of circumstances. First, readiness is the concern of almost all defense management functions. But each

function has different interests in mind in its decision making. Logisticians, for example, view readiness from a perspective quite different from those of operational commanders or research and development engineers. Second, there is more difficulty in specifying "output" measures for some combat units and weapon systems than others. In an effort to reconcile definitions with measures, some definitions get stated in terms which do not reflect a potential wartime output with respect to unit or weapon system missions. Third, a topic of considerable debate is whether some threat should be explicitly incorporated in the definition of readiness or whether some other term better connotes the capability to wage war against a specific enemy. We have chosen to take the latter point of view for reasons which will become clear later.

2. Lack of quantifiable output measures for all mission and weapon system types. While efforts are underway to develop output measures for ships and land forces, only aircraft output measures are sufficiently developed to be useful in resource allocation. Many of the measures currently employed are static measures such as operationally ready rates or mission-capable status rates. These measures are justifiable only when a unit or weapon system is operating in peacetime at a wartime activity level. When this condition does not exist, dynamic measures are also necessary. For aircraft, "availability" appears to be an adequate static measure and "maximal sortie generation capability over time" a reasonable dynamic measure. Another type of measure, the C-rating of the Force/Unit Status and Identity Report, is useful to operational commanders; but the subjective content of such measures and the limited scale of measurement present problems in developing the linkages between resources and readiness. These measures can, however, account for detailed differences in mission from unit to unit, while some other measures do not.

3. Myriad factors involved in the interrelationships which affect readiness. To those newly initiated in the intricacies of the logistics support of a weapon system, the number of variables and the complexity of the relationships between them may seem overwhelming. This renders an adequate understanding of the effect of the support process on materiel readiness a difficult problem in information processing and analysis.

4. Inadequate visibility of resource allocation and application. The categorization of budget aggregates used to allocate resources and the financial reporting systems designed to monitor resource application are not sufficient for controlling the impact of these resources on individual weapon systems or combat units. Field commanders and logistics managers have considerable flexibility in the redistribution of funds, particularly O&M funds. While some flexibility is necessary to permit a capability to respond to changing and unanticipated circumstances, the present situation leaves top-level decision makers virtually in the dark with respect to actual resource impacts on readiness. The development of a Logistics Resource Annex (LRA) to the Five Year Defense Program (FYDP) is intended to bridge the gap to some extent; but there exist institutional barriers to proper implementation of such a reporting system. Another problem is the vertical organization of reporting systems. That is, information is typically aggregated by simply adding and averaging factors without consideration of the horizontal interrelationships between factors. The highly aggregated information that results is often devoid of meaning and impossible to relate to "real-world" readiness.

5. Excessive cost of conducting readiness exercises. Readiness exercises potentially offer one of the best methods for assessing actual readiness, for it is only during such exercises that most units are stressed to their wartime capability. Readiness exercises, however, are very expensive

to conduct and the documentation of exercises to determine resource implications is often given subordinate priority to the demonstration of primary mission capability. Also, readiness exercises do not always adequately simulate wartime environments.

6. Inadequate analytical tools for projecting resource impacts on readiness: Even if the above mentioned difficulties could be overcome, there would still be problems in performing analysis in support of resource allocation decisions. For aircraft, some bright spots include the LMI Availability Model, used by the Air Force to evaluate spares procurement and depot component repair program decisions, and a sortie generation model also under development at LMI. All models, however, make broad assumptions which may or may not be valid under changing circumstances. The need is for tools which are more robust with respect to assumptions, but are no larger or more complicated than the present generation of models.

7. Absence of adequate coordination and guidance. Implementation of changes in response to the above problems would be very difficult without the organizational mechanisms required for coordinating readiness-related resource allocation and policy decisions. The traditional management of logistics by function, for example, can lead to uncoordinated resource allocation decisions which may not be in the best interests of overall readiness. For example, the procurement of additional spare components (a supply function) without consideration for component repair capability (a maintenance function) could lead simply to an increased backlog of unserviceable spares.

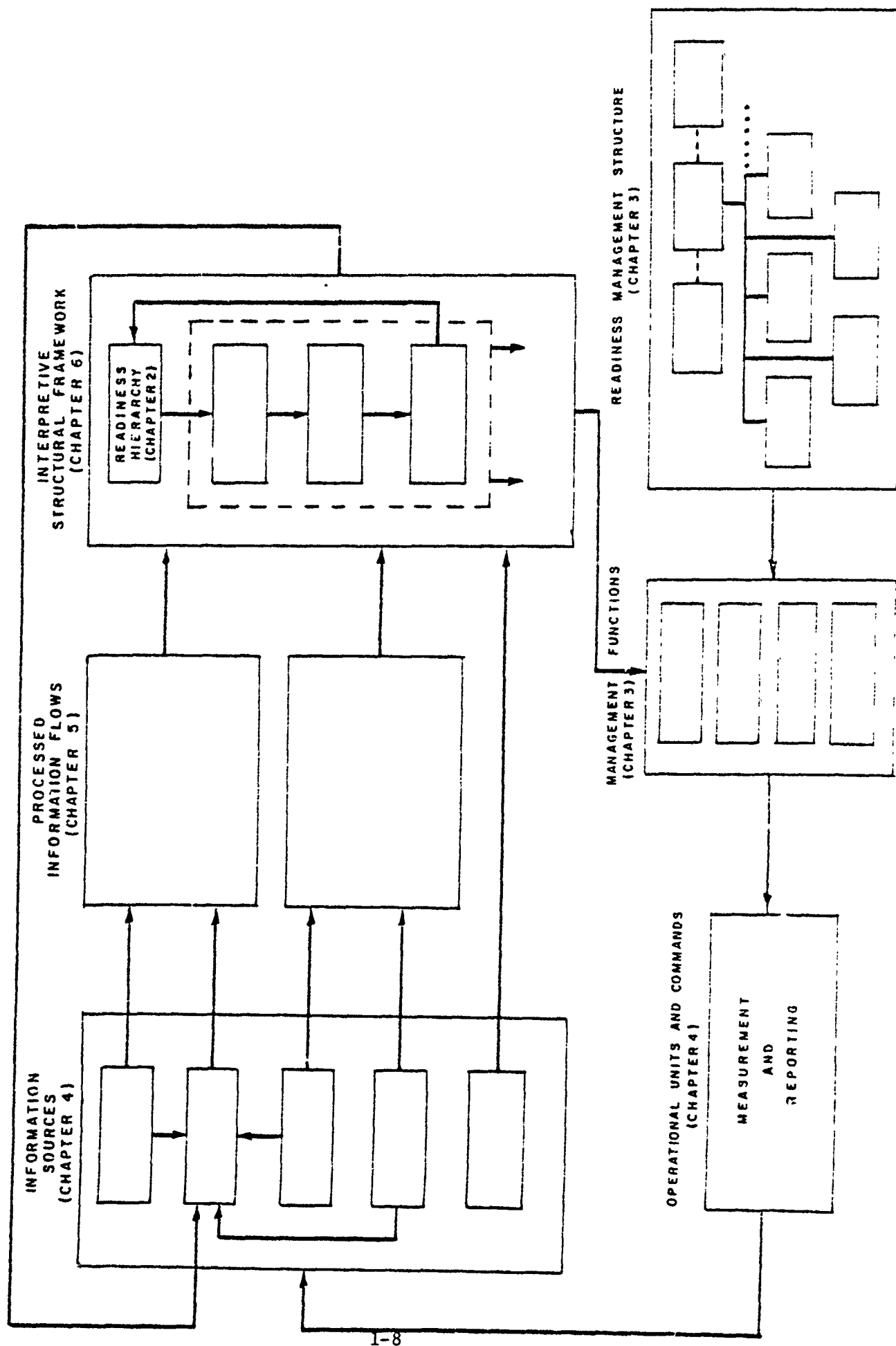
8. Lack of formalized information flows. The specification of formal information flows required to manage readiness follows from the consideration of the above problem areas. At present there are at least two information flow requirements which need improvement and formalization: the documentation

which accompanies the Program Objective Memorandum (POM) of each Military Department and the annual readiness report submitted to Congress.

CONCEPT OVERVIEW

In subsequent chapters of this report, we discuss each of the above difficulties in the context of an integrated management concept. A schematic representation of that concept is shown in Figure 1. The various parts of the figure are discussed in the chapters indicated. In Chapter 2, the foundations for the concept are established by defining readiness and distinguishing it from terms like effectiveness and capability. Chapter 3 presents a readiness management structure, including the functions to be performed by offices assigned readiness responsibilities. Chapters 4,5, and 6 address the problems of generating information on readiness and resources, formalizing the flow of that information, and interpreting the implications of management information for use in evaluating readiness-related policy and resource decisions. Chapter 7 concludes with a proposal for implementing the concept and for developing a long-range plan for converting the concept into a DoD readiness management system.

FIGURE 1. OVERVIEW OF MANAGEMENT CONCEPT: CHAPTER FLOW DIAGRAM



2. READINESS TAXONOMY AND DEFINITIONS

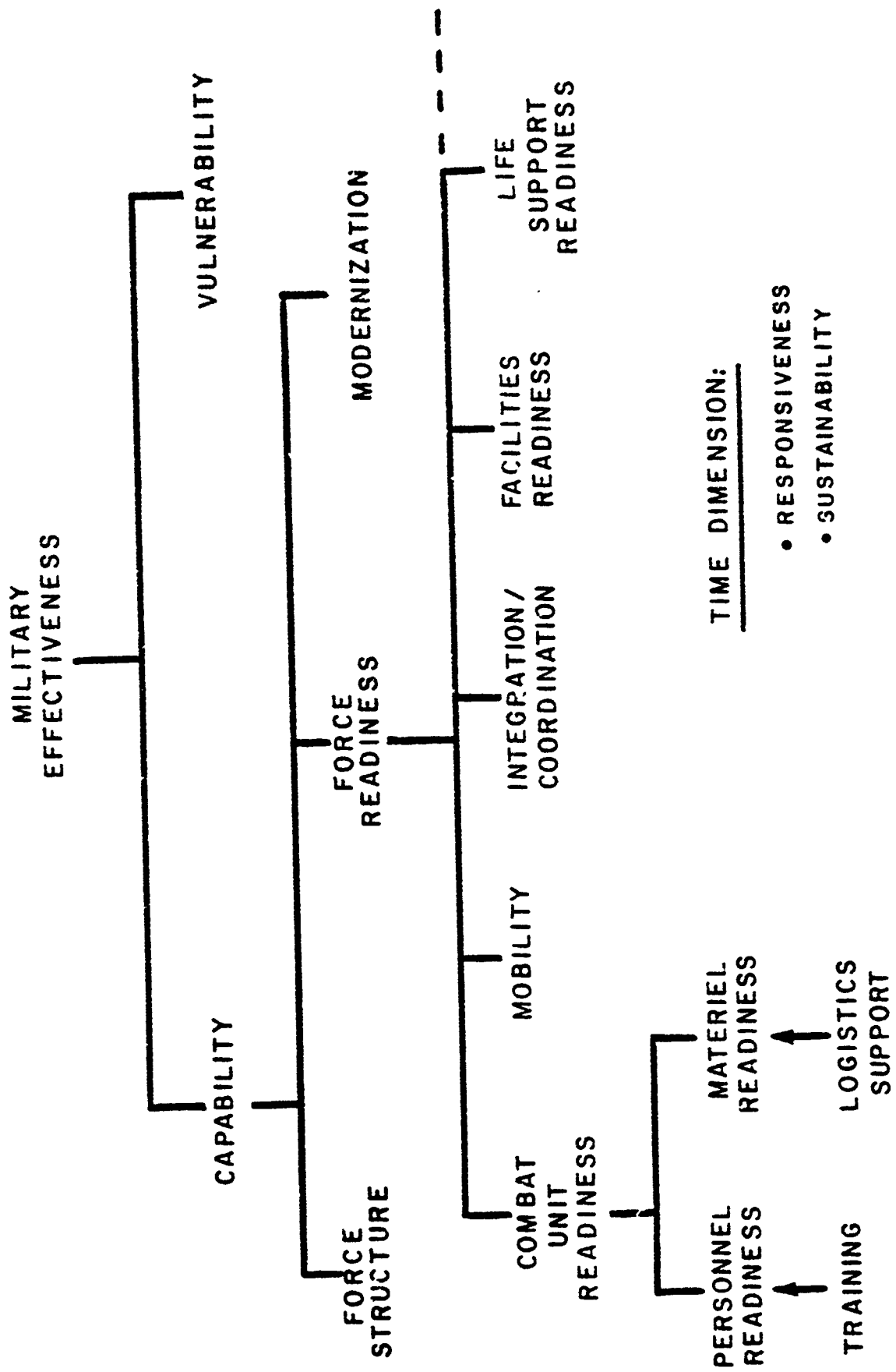
The word "readiness" is fraught with conceptual and definitional problems. To the average citizen, and even to many military personnel, a state of readiness implies the capability, with a high degree of confidence, of winning any war, fought any place at anytime. To these people a military organization that cannot successfully respond to a threat is not ready. The same word, however, is used by defense administrators, military strategists, and logisticians with more narrow connotations. In order to minimize confusion, we attempt here to maintain the narrow usages common in the defense establishment. To do this we identify different types of readiness, each corresponding to a different usage of the word. An added advantage of this approach is that it allows us to concentrate on one aspect of the problem at a time. In this report, for example, we concentrate on "materiel readiness."

Clarifying terms associated with readiness and specifying types of readiness in this way leads to a readiness tree/hierarchy like that shown in Figure 2. We refer to this classification scheme as a readiness taxonomy. Beginning at the top and working down, we will discuss each term.

Military Effectiveness. "Effectiveness" is the word we found most often used to describe the ability of the military establishment to respond successfully to any threat.

Definition 1: Military effectiveness is the difference between DoD capability and the perceived capabilities of potential enemy threats. Maximizing military effectiveness, then, represents the overall objective of national defense policy. But it is a relative concept, continually changing as the perception of enemy threats changes.

FIGURE 2. READINESS TAXONOMY



Capability. Given the types of mission activity required to be effective, "capability" refers to the absolute levels of activity which are currently possible. It includes both qualitative and quantitative factors; that is, force structure and the degree of modernization, as well as force readiness, are important elements of capability.

Definition 2: Capability is the level of successful mission activity possible by DoD forces for given mission and scenario specifications.

Because capability is defined with respect to specific scenarios, it is a dynamic concept and dependent on the characteristics of perceived threats. As an objective of defense policy, maximizing capability is reasonable only if scenarios have been realistically formulated and missions adequately defined.

Vulnerability. As the complement to capability, "vulnerability" refers to weaknesses in DoD forces and military operations which threaten the survival of those forces. Vulnerability differs from the concept of effectiveness in that it does not represent an overall assessment, but rather addresses specific weaknesses, whether they be in force structure, force readiness, or modernization with respect to specific scenarios. For example, units or equipments located in close proximity may be more vulnerable than units or equipments dispersed over a wide area. Likewise, fuel pipelines and systems exposed to enemy fire are more vulnerable than the same pipelines and systems camouflaged or buried underground. Determination of vulnerability requires a thorough and detailed assessment of the strengths of potential enemies.

Definition 3: Vulnerability is the potential reduction in military effectiveness due to specific weaknesses in DoD forces and military operations for given mission and scenario specifications.

Force Structure, Force Readiness, and Modernization. "Force structure," "force readiness," and "modernization" are the terms we found used most often to describe the elements of capability.

Definition 4: Force structure is the quantity, mix, and location of military facilities, combat units, weapon systems, equipments, and personnel.

Definition 5: Force readiness is the ability of a force structure, in a given state of modernization, to conduct the military operations expected of it.

Definition 6: Modernization is the extent to which military weapon systems, equipments, and facilities are not limited by obsolescence or age.

Note that an accurate assessment of force readiness requires the specification of expected mission activity for a given force structure, in a given state of modernization. Hence, the quantity, age, and original design characteristics of weapon systems are not factors in our definition of readiness. They are, of course, important aspects of DoD capability. Furthermore, these factors do have an impact on the ability to maintain a satisfactory level of readiness, given the existing support structure.

Unit readiness. One way of subdividing force structure, force readiness, and modernization is to identify individual force types, e.g., tactical fighter, armor, mechanized infantry, etc. These force types are organized into units, with the readiness of many of these units reported through the Force Status and Identity Report (FORSTAT). We use the term "unit" to refer to any organizational entity that performs a distinct military function. Examples of units include battalions, squadrons, ships, hospitals, etc. Hence, the next level of the readiness hierarchy is categorized into the broad organizational functions performed by different units. These functions include combat, mobility, integration/coordination, facilities support, life support, etc. The readiness of the organizational entities that perform these functions is indicated by their ability to execute the tasks required of them. In Figure 2, only force readiness is subdivided, but force structure and modernization could be similarly partitioned. For purposes of materiel and

personnel readiness (the next level of the hierarchy), units are further subdivided into weapon systems/equipments and people. It is possible, then, to aggregate materiel and personnel readiness to obtain a total view of "force type" readiness as opposed to "unit" readiness. The unit level of the hierarchy, however, is essential in highlighting the interrelationships among the organizational functions which are intrinsic to force readiness, as well as force structure and modernization.

Definition 7: Combat unit readiness is the ability of a military combat unit to perform the mission(s) or function(s) that it has been assigned.

No distinction is made in this definition with respect to how long the unit can sustain its level of mission activity. Some units may be expected to conduct missions primarily during initial surge while others will be expected to sustain their activities over longer periods of time.

Definition 8: Mobility is the ability of the DoD to move people, equipment, and supplies from one location to another within specified times.

Mobility has both large-scale (worldwide) and small-scale (intratheater) connotations. Mobility forces (e.g., military airlift, the merchant fleet, etc.) are responsible for moving people, equipment, and supplies to a theater of conflict. Their ability to do so is generally referred to as "deployability." The mobility of a unit within a theater is a function of the particular organization and mobility plans of the unit and the design of its equipment. Intratheater mobility is being recognized as an increasingly important and underemphasized aspect of military effectiveness. The pre-positioning of equipment and materiel provides a partial alternative to mobility.

A vitally important, although often elusive, element of force readiness is represented by the ability to coordinate the various units of a command

(e.g., a Unified or Specified Command) within a particular theater of conflict, and to integrate these commands with allied commands to be effective against a specific threat. This ability depends to a large extent on the adequacy of the Command, Control, Communications, and Intelligence (C³I) procedures, equipment, personnel, and facilities.

Definition 9: Integration/coordination is the ability of command, control, communications, and intelligence activities to support the DoD commands in the conduct of their military operations.

Facilities support is an essential element for the successful performance of combat, mobility, and C³I functions. It consists of the support of the installations, real property assets, and base operating activities to which DoD has access.

Definition 10: Facilities readiness is the ability of DoD facilities to support military units in the performance of their assigned mission(s) or function(s).

Facilities readiness is generally indicated by the backlog of maintenance and repair on those real property assets considered critical to mission operations, e.g., airfields, shelters, fuel handling equipment, fire fighting equipment, and snow removal equipment.

Life support readiness refers to the quality of those services which directly affect personnel health and morale, e.g., medical, chaplain, food, and recreational services. Other organizational functions need to be identified and classified, also. These broad functional areas need then to be broken down into more detailed functions.

Subdivisions of Unit Readiness. Unit readiness has traditionally provided the core concept for DoD readiness management, in part a result of the responsibility given JCS for monitoring readiness. To better pinpoint problem areas, FORSTAT subdivides unit readiness into a number of resource categories. These categories, however, have not proved particularly useful in

trying to relate resources to readiness. The subdivision of unit readiness which we select here coincides with current thinking in OASD (MRA&L) about the best way to simplify the resource allocation problem. To some extent, it also reflects the way in which readiness-related resources are currently managed in the programming process. It should be kept in mind, however, that these subdivisions of unit readiness are highly interdependent, and that the consideration of one to the exclusion of the other raises serious methodological questions. But the framework does provide a point of departure for an initial investigation of readiness management.

Definition 11: Materiel readiness is the ability of DoD weapon systems and equipments to perform the mission(s) or function(s) for which they are designed or organized.

Definition 12: Personnel readiness is the ability of DoD personnel to perform the mission(s) or function(s) for which they are trained or organized.

DoD logistics systems are responsible for maintaining weapon systems, equipments, and personnel supplies in a condition sufficient to permit DoD units and commands to perform their mission(s) or function(s), in both peacetime and wartime. In peacetime, the functions are primarily training functions. With respect to war, there is a need for both responsiveness and sustainability. Responsiveness and sustainability represent another dimension of the readiness hierarchy, the time dimension. As such, they provide another breakdown of capability, with every element of the hierarchy in Figure 2 containing both responsiveness and sustainability aspects.

Logistics as an organizational function, then, provides training in peacetime and responsiveness/sustainability in wartime to existing forces and the organizational functions they perform. Logistics and training are, therefore, best viewed along another dimension relative to the organizational functions already in the hierarchy--combat, mobility, integration/coordination, facilities support, life support, etc.

Definition 13: Responsiveness is the capability of military forces, units, weapon systems, equipments, and personnel to initiate military operations within specified times given some warning or mobilization order.

Definition 14: Sustainability is the capability of military forces, units, weapon systems, equipments, and personnel to maintain a specified level of wartime mission activity for specified times.

In this report, we illustrate our concept by concentrating on materiel readiness and using the air superiority mission of the F-4 as a hypothetical example. Within the definitions presented in this chapter, the materiel readiness of the F-4 with respect to its air superiority mission consists of the ability of aircraft, their air-to-air munitions and fire control systems, and the logistics system which supports them, to fly assigned missions when and as long as needed. To measure the materiel readiness of F-4 aircraft and to use it as a decision criterion in resource allocation, by itself, requires making the following assumptions:

- sufficiently qualified and trained aircrews are available to perform the F-4 mission;
- F-4 squadrons can be deployed to the theater of conflict in sufficient time to perform the mission;
- the facilities required to perform the F-4 mission are available and in satisfactory condition;
- all combat units involved in a potential conflict are adequately coordinated to allow F-4 squadrons to perform their mission;
- all combat units are adequately manned, equipped, and managed, and are located in the right place to perform their assigned missions;
- the design of the F-4 is appropriate for performing the mission for which it was designed;
- the missions assigned to all combat units have been adequately formulated to confront potential threats.

Since these assumptions seldom, if ever, completely obtain, viewing materiel readiness in isolation of the other subdivisions and levels of readiness can be misleading and dangerous. In the resource allocation process, there are

interdependencies and tradeoffs both laterally and vertically in the readiness tree of Figure 2. Furthermore, as will become apparent in a later chapter, additional assumptions must be made in performing resource analysis within materiel readiness itself.

The point is that while the proposed definitions may seem reasonable, they are loaded with methodological problems in measurement and analysis. These problems also make it difficult to establish reasonable readiness goals, standards, or requirements. This difficulty, along with other problems with the implementation of standards, suggest that alternative means for managing readiness may be appropriate. This possibility should be kept in mind in reading the remainder of the report.

3. READINESS MANAGEMENT STRUCTURE AND FUNCTIONS

To provide the coordination essential for the proper development, implementation, and utilization of a DoD readiness management system, a formal readiness management structure is needed. We use the term "management structure" to refer to the official assignment of responsibilities to specific offices or individuals, not necessarily to a change in the titles of those offices or individuals. The selection of such a structure must incorporate some very pragmatic considerations. Any change in management responsibilities or organizational titles is bound to be met with some resistance. Furthermore, differences of opinion with respect to the "best" management arrangement are inevitable. The minimization of such conflicts is probably a more important consideration than the details of the structure selected.

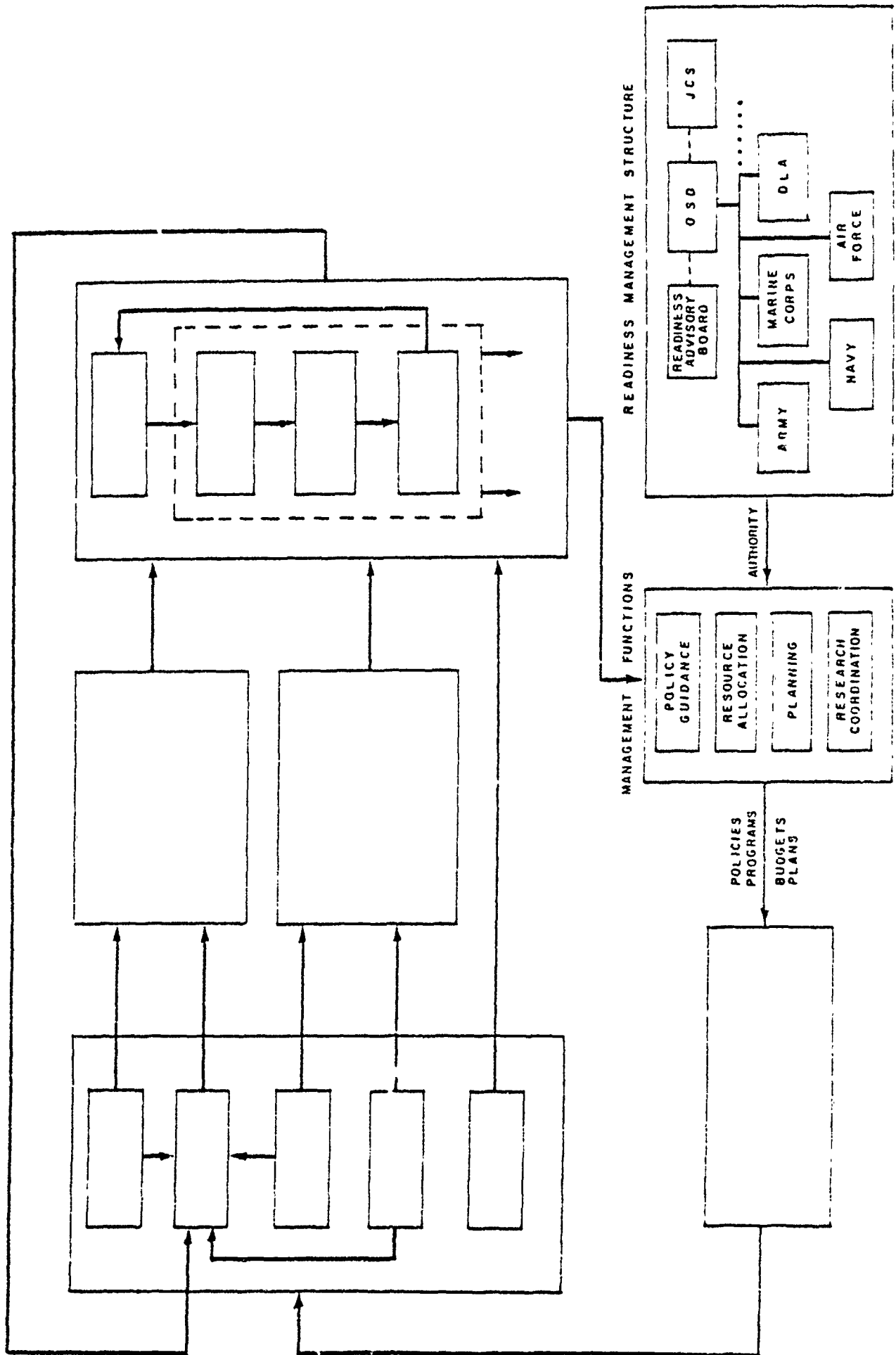
Our concept for a readiness management structure and the functions it should perform is depicted in Figure 3. The elements of that structure are:

- a readiness office in the Office of the Secretary of Defense (OSD);
- Service and Agency readiness offices; and
- a Readiness Advisory Board.

While our concerns are not with JCS functions, coordination with JCS is important.

The OSD readiness office would serve as a point of coordination for all DoD-wide readiness management efforts. Because the focus of this office would be on relating resources to readiness, particularly in the programming process, the Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics)---OASD(MRA&L)---is the logical location for such an office. In addition, the ASD (MRA&L) is currently the designated chairman of

FIGURE 3. OVERVIEW OF MANAGEMENT CONCEPT:
 READINESS MANAGEMENT STRUCTURE AND FUNCTIONS



the Readiness Management Steering Group (RMSG), and OASD (MRA&L) personnel have been the primary source of staff support for the RMSG. Since it is important for the OSD readiness office to have top-level visibility, it should probably be headed by a Deputy Assistant Secretary of Defense, if not a higher level official. While initially the emphasis would be on materiel readiness, eventually the office would also analyze personnel and facilities resources, as well as overall force readiness.

The Service and Agency readiness offices would be counterparts to the OSD office. Some Services already possess readiness organizations. The important point is that one individual should be officially designated with the responsibility for coordinating all ongoing efforts. This individual should be accessible to the OSD office and in a position of top-level visibility in his own Service. The appropriate rank for this position is probably at least an O-6, if not a flag officer. A common problem to be avoided in designating a Service readiness office is the tendency for such an office to serve a mail answering function, rather than spending its time performing analysis, evaluation, and planning functions. This is one of the reasons behind the need for top-level visibility.

The functions of these readiness offices, in both OSD and the Services, would include the following:

- to collect, analyze, and evaluate readiness information in support of the Program Objective Memoranda (POMs), budgets, issue papers, and annual readiness reports to Congress;
- to issue guidance with respect to the specific information to be included in the POMs and the annual readiness reports to Congress. and the improvement of readiness management in general (e.g., Consolidated Guidance, directives, instructions, regulations, memoranda);
- to formulate, update, and monitor progress toward achieving the objectives of a long-range plan for developing the readiness and management capability required; and

- to sponsor, monitor, and evaluate research directed at enhancing the state of the art in readiness management.

Other routine functions would include the preparation of the readiness section of the SecDef Defense Report, preparation of readiness-related Congressional testimony, and generally serving as a "corporate memory" for readiness in DoD and in each Service. Management tools may be useful in organizing available information and generally assisting the offices in performing these functions. We refer to an integrated system of management tools as a decision support system. A possible structure for such a system will be discussed in Chapter 6.

The Readiness Advisory Board would meet periodically to brainstorm selected issues and to offer advice to the readiness offices. This Board would consist of representatives from OSD, the Services and Agencies, and JCS, and technical experts from outside the Defense Department. The inclusion of outsiders is a feature not currently possessed by the RMSG, but one which could be valuable in providing fresh insights. These outsiders would probably come from other government agencies, non-profit institutes, and universities.

The proposed readiness management structure could not, of course, be implemented immediately. However, existing offices could be officially recognized as the coordination point for the first step of a readiness management system--materiel readiness. This could be accomplished without formally changing titles. As the readiness management capability develops and is expanded, the formal changes could be incorporated.

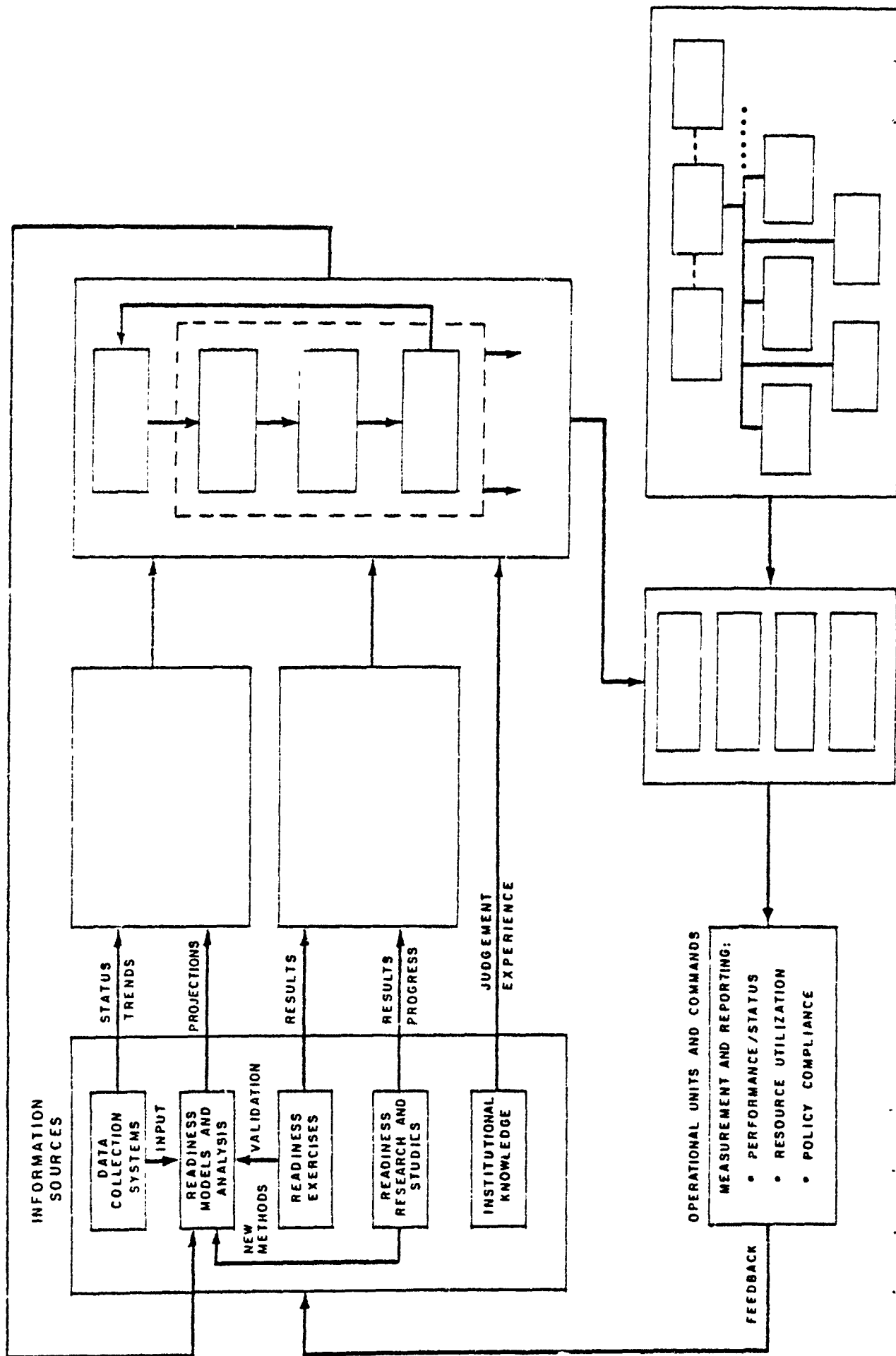
As the characteristics of a DoD readiness management system become more apparent, internal changes in the readiness management structure may become desirable. These changes might reflect, for example, an orientation to forces or missions; a recognition of the interrelationships among force structure, force readiness, and modernization; or new approaches to allocating resources.

4. GENERATION OF MANAGEMENT INFORMATION

When readiness has been defined and a structure specified for coordinating readiness management activities, the need is for information to assist management in the performance of its functions. That information takes on a number of different forms in our concept. First, there is the information generated within the Military Departments and DoD Agencies (discussed in this chapter). Second, there is the formalized and aggregated information sent to the coordination point in OSD (discussed in Chapter 5). Third, there is the information after it is structured, analyzed, and interpreted by OSD for the purpose of evaluating readiness-related policy and resource decisions (discussed in Chapter 5).

The sources of information generated within the Military Departments and DoD Agencies are shown as elements of our concept in Figure 4. While each of these elements will be discussed separately, the distinctions among them are not always clear. Measures, for example, can be observed directly or they can be derived analytically. As such, algorithms or models may be incorporated into the information processing mechanism of a data collection or reporting system. In these cases, it is virtually impossible to discuss measurement and reporting systems without mentioning analytical tools. To circumvent this semantic problem, it is becoming popular to refer to a system which incorporates measurement, reporting, data collection, and analysis as a "management system." Our selection of systems and models for review in this report is based on the emphases the Services themselves are placing on efforts to improve their capability to relate resources to readiness.

FIGURE 4. OVERVIEW OF MANAGEMENT CONCEPT: INFORMATION GENERATION



MATERIEL READINESS MEASUREMENT

There are currently two primary types of measures of readiness used throughout DoD. The first is the C-rating system used in FORSTAT (Force Status and Identity Report) reporting. This system provides measures of combat unit readiness that are monitored by JCS. Each Service has supported these measures with their own reporting systems; the Air Force, for example, has its Unit Capability Measurement System (UCMS), and the Navy has its NAVFORSTAT M-rating system for ship readiness. In February 1980, UNITREP (Unit Status and Identity Report) will replace FORSTAT in an attempt to standardize Service reporting of unit readiness even further.

The second type of measure is the operational readiness (OR) rate or mission-capable (MC) status measure. Each Service has a reporting system which supports this type of measure but there is not complete uniformity in either the definitions or names given to the measures used. Improved consistency is, however, being sought. All Services, for example, will soon have standardized measures for aircraft.

There are a number of problems with these measures, particularly in the context of trying to relate them to resources. C-ratings are, first of all, highly subjective, requiring the exercise of judgment on the part of unit commanders. Subjectivity is not inherently undesirable. However, when the reports are used to judge the performance of a commander, the credibility of the data is brought into question. There is also likely to be substantial variability from unit to unit in the judgmental aspect of the reports. Another problem with C-ratings is the scale of measurement used. This scale is not conducive to identifying the analytical links between resources and readiness, and as a consequence, to projecting the amount of readiness "bought" for funds "requested." The Center for Naval Analyses is more optimistic than we about the usefulness of FORSTAT type measures in relating

resources to readiness.¹ They do, however, foresee numerous difficulties and the need to modify the current reporting system.

The OR/MC type of measure represents an effort to circumvent the problems of subjectivity. However, these measures are not good indicators of the output of a weapon system or its dynamic capability to perform its mission(s). OR/MC status represents the average percentage of time that the weapon system being reported on has been in a satisfactory condition to perform its mission(s) based on peacetime activity levels. Only when peacetime activity levels are comparable to wartime activity levels and when the particular mission calls for the weapon system to be able to respond without warning are the OR/MC measures good indicators of materiel readiness as we have defined it.

The problem has surfaced very clearly in attempts by the Air Force to establish goals/standards of 24% for aircraft Not Operationally Ready due to Maintenance (NORM) and 5% for aircraft Not Operationally Ready due to Supply (NORS). The standards were discontinued when it was realized that if peacetime flying activity was below the wartime sortie rate, there might be a distinct advantage to performing diagnostic and preventive maintenance on aircraft that are not immediately needed for the peacetime flying program. Furthermore, if the aircraft mission does not require that it be capable of responding without warning, rather than repairing non-mission capable aircraft immediately, priorities might be better placed elsewhere.

Some variations to these measures exist or are in the process of implementation. These variations are designed to circumvent some of these

¹See Stanley A. Horowitz, "Second Advisory Committee Meeting Relating Resources to Readiness Study -- Phase I," Center for Naval Analyses, Memorandum 78-1247, 1978.

problems. UCMS reports aircraft condition based on projected wartime capability by including:

- mission reaction time;
- wartime maintenance work days;
- unrestricted use of WRM; and
- unrestricted cannibalization.

The resulting materiel condition percentages are substantially higher than MC rates. UNITREP will likewise emphasize wartime requirements more than FORSTAT does. UNITREP will also expand the scale of measurement from four to five status categories (C-ratings).

JCS is preparing an annual force readiness report which will assess shortfalls in ten resource categories with respect to the most stringent readiness requirements. At present, only four broad resource categories are included in FORSTAT reports: equipment on hand, equipment status, personnel, and training. The process of tracking through FORSTAT logic to identify specific resource shortfalls is very complicated, and the effects of logistics support provided by organizations external to the unit are not easily traceable.

In July 1979, the Navy implemented the Subsystem Capability Impact Report (SCIR) for reporting aircraft materiel readiness. While completely compatible with the DoD-wide mission-capable status reporting requirements, it goes well beyond by identifying the specific subsystems which are causing reduced mission-capable status. Relative degrees of readiness, corresponding to different missions and conditions, are made visible by specifying the subsystems required for each mission/condition combination. SCIR has been suggested as a prototype for all materiel readiness measurement in DoD.

Despite the difficulties of current readiness measures, it is very likely that the dynamic output measures needed cannot be directly and objectively

reported. In this context, the present readiness reporting systems provide a valuable source of real-world information with which to compare more analytically derived measures. Adequate output measures will be different for each force type, and will often vary from weapon system to weapon system, unit to unit, and, perhaps, mission to mission. Here, we will discuss three primary weapon system types: aircraft, ships, and ground combat vehicles. Output measures have not yet been adequately formulated for all three, but there are efforts underway in all Services to do so. In evaluating materiel readiness, output measures selected should be related to those activities that generate demands for logistics support.

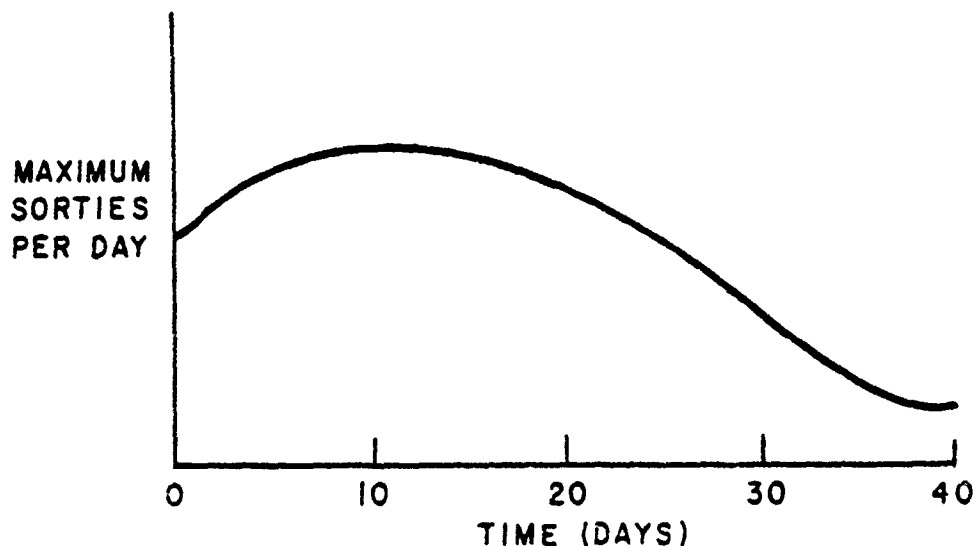
Aircraft. The activity that best relates to the generation of demands for aircraft logistics support is probably "sorties." It is the take-offs, landings, and adverse environmental conditions when airborne that induce failures. While ground environmental conditions also have an effect and do vary from airfield to airfield, the percentage of failures attributable to these circumstances is believed to be substantially lower than those attributable to sorties. Sorties do not represent the final output of an aircraft mission, e.g., the probability of placing a payload on target. But all aircraft missions require flying sorties, and if we assume adequate aircrew proficiency, munitions reliability, and fire control system accuracy, maximal sortie generation capability is a reasonable measure of materiel readiness for evaluating resource needs.

While maximal sortie generation capability over time can serve as a dynamic wartime output measure, another measure may also be needed to indicate responsiveness. For missions which require the ability to respond immediately, peacetime aircraft availability is an important static measure. To avoid some of the problems previously mentioned with respect to OR/MC

rates, "availability" is sometimes defined differently. In the Air Force Aircraft Availability Model, for example, an aircraft is considered unavailable for a mission if it is missing any component required for that mission and a spare is not immediately available through the local supply system. Hence, the delay time involved in removing and replacing a component is not included in the calculation of availability. The standard definition of availability does include repair time.

The Logistics Capability Measurement System (LCMS) of the Air Force currently uses availability as the criterion in allocating spares procurement and depot component repair dollars to individual weapon systems. Using projected supply availability rates, the Air Force is in the process of combining this model with the Logistics Composite Model (LCOM) to produce sortie capability projections. LMI is also developing a sortie generation model as an extension to the Availability Model. Availability and sortie capability are analytical measures in that they are derived from models rather than measured directly. Availability is measured as a percentage. For sortie capability to be a dynamic measure, it must be displayed as a time profile, as in Figure 5.

FIGURE 5. SORTIE CAPABILITY



There are some problems with analytically derived measures, namely that many assumptions must be made in the formulation of the models or algorithms used. For this reason, we would not recommend the discontinuation of direct measures; they provide a useful check on the analytical measures. However, the analytical measures are generally more appropriate as criteria in relating resources to readiness and making resource allocation decisions.

Ships. The wartime activity levels for most of the subsystems and equipments aboard a ship are not substantially different from peacetime levels, the primary exception being shipboard weapons and fire control systems. With these exceptions, peacetime availability rates are reasonable measures of materiel readiness. The problem with developing a measure of the materiel readiness of a ship as a whole is that a ship is usually designed to perform many types of mission, and there is substantial redundancy in the equipments required for these missions. The difficulty this raises is well illustrated by efforts to develop such a measure. While these efforts have been highly professional, the analytical derivations resulting are so complicated that only advanced mathematicians can understand them.²

The Navy is currently sponsoring research to develop a measure of materiel readiness for ships in terms of the probability of mission success. This measure uses reliability block diagrams which have been developed by the Naval Ship Engineering Center and are used in the Navy's simulation model, TIGER. By identifying the equipments required to perform the functions for different engagement categories, a materiel readiness matrix can be formulated. At present, implementation of this measurement concept would involve the identification of equipment deficiencies through Casualty Reports

²See, for example, J.L. McVoy, "The Analysis and Measure of a Ship's Materiel Condition and Readiness", Technical Memorandum, Office of the Chief of Naval Operations, 1 April 1970.

(CASREPTs). Aggregation to warfare types and the ship as a whole is possible if the relative importance of the various engagement categories and warfare types is specified. This measure is much simpler to derive than previously developed measures.

The need, once such a measure is implemented, is to connect it to a model of the logistics system--as, for example, the Aircraft Availability Model connects spares levels and component repair to aircraft availability--in order to evaluate the impact of resource decisions on materiel readiness. The Navy is sponsoring developmental work for such a model, the Operational Availability Allocation Model (A_OAM). This is also a necessary step if the wartime utilization and support of shipboard weapons is to be assessed.

Combat Vehicles. Traditionally, the materiel readiness of Army equipment has been measured by comparing the available and operable inventory with a designated requirement or standard. The difference between the two is an indication of the readiness of the particular type of equipment. As previously discussed, this type of measure is static only, and does not reflect the capability of the Army logistics systems to support the equipment in wartime. The Readiness Indicator Model (RIM), developed by the Army's Concepts Analysis Agency (CAA), goes a step further by calculating expected deployment/employment delay times and comparing them with established requirements. RIM does require, however, that assumptions be made about the availability of resources external to the combat unit.

A dynamic output measure which is frequently mentioned in discussions of combat vehicle materiel readiness is miles traveled, with miles traveled per day representing a wartime capability. This measure is much more difficult to derive, however, than sorties flown by an aircraft, for the type of terrain negotiated by a combat vehicle introduces significant variability into the

measurement. OSD, in coordination with the Army, is currently sponsoring research to develop output readiness measures for Army combat units, e.g., platoon attacks per day. The intent is to link these output measures to resources with a simulation model.

The problem of measuring materiel readiness as distinct from personnel readiness is particularly bothersome for ships and ground combat equipment. While aircrew proficiency and aircraft maintenance skills certainly require very sophisticated technical training, the impact of personnel and training resources on the materiel readiness of ships and ground combat equipment represents an even more complicated relationship. The ramifications of personnel qualifications and training programs for materiel readiness are multi-faceted and involve such intangible factors as morale, personnel retention, combat unit cohesion, and work quality.

We have not discussed materiel readiness measures for missiles, ordnance, weapons, or electronics/communications equipment here. With the exception of some of the newer, sophisticated electronics equipment, we do not think these classes of materiel represent as difficult a measurement problem as those mentioned above, nor do they involve the same level of logistics resources. They are, of course, extremely important, and should be a part of any DoD readiness management system.

To illustrate the measurement philosophy we are suggesting, F-4 materiel readiness would involve a combination or vector of at least four types of measures: UCMS, MICAP, Availability, and Sortie Capability. This vector consists of both static and dynamic, objective and subjective, directly reported and analytically derived measures. UCMS provides a subjective assessment of the wartime capability of a squadron. Four aspects of this

capability are specifically addressed: aircraft availability, aircrew training, logistics, and support personnel. The aircraft availability percentage reported in UCMS will generally be higher than the peacetime mission capable status reported through MICAP (Mission Capability Allocation System). Table 1 lists the mission capable status categories for Air Force aircraft.

TABLE 1. MISSION CAPABLE STATUS CATEGORIES

FMC	- Full Mission Capable
PMCS	- Partial Mission Capable - Supply
PMCM	- Partial Mission Capable - Maintenance
PMCB	- Partial Mission Capable - Both
NMCS	- Not Mission Capable - Supply
NMCM	- Not Mission Capable - Maintenance
NMCB	- Not Mission Capable - Both

An FMC aircraft can perform all of its primary missions. A PMC aircraft can perform at least one of its primary missions. An NMC aircraft can perform none of its primary missions. The S, M, and B following PMC and NMC refer to whether the reduced capability is due to the need for a spare part, a maintenance action, or both, although an aircraft on which no maintenance can be performed until a spare part is received is in a PMCS or NMCS status.

Prior to the inclusion of the "Both" category, it was difficult to identify supply problems through examination of materiel condition rates. Figure 6, for example, shows a trend in OR rates for all F-4 aircraft. The decrease in OR rate over the four-year period appears to be a maintenance problem. However, one of the factors which contributed to the relatively stable NORS rate was the method by which "NORS incidents" were terminated.

NORS incidents, now referred to as MICAP incidents, are an account of the number of times a spare component was not available in the local supply system when needed (within certain reporting guidelines). A NORS incident occurs every time an aircraft is transferred into a NORS status. The shorter the time it takes to terminate the incident, the lower will be the NORS rate.

FIGURE 6. F-4 OPERATIONALLY READY RATE TRENDS

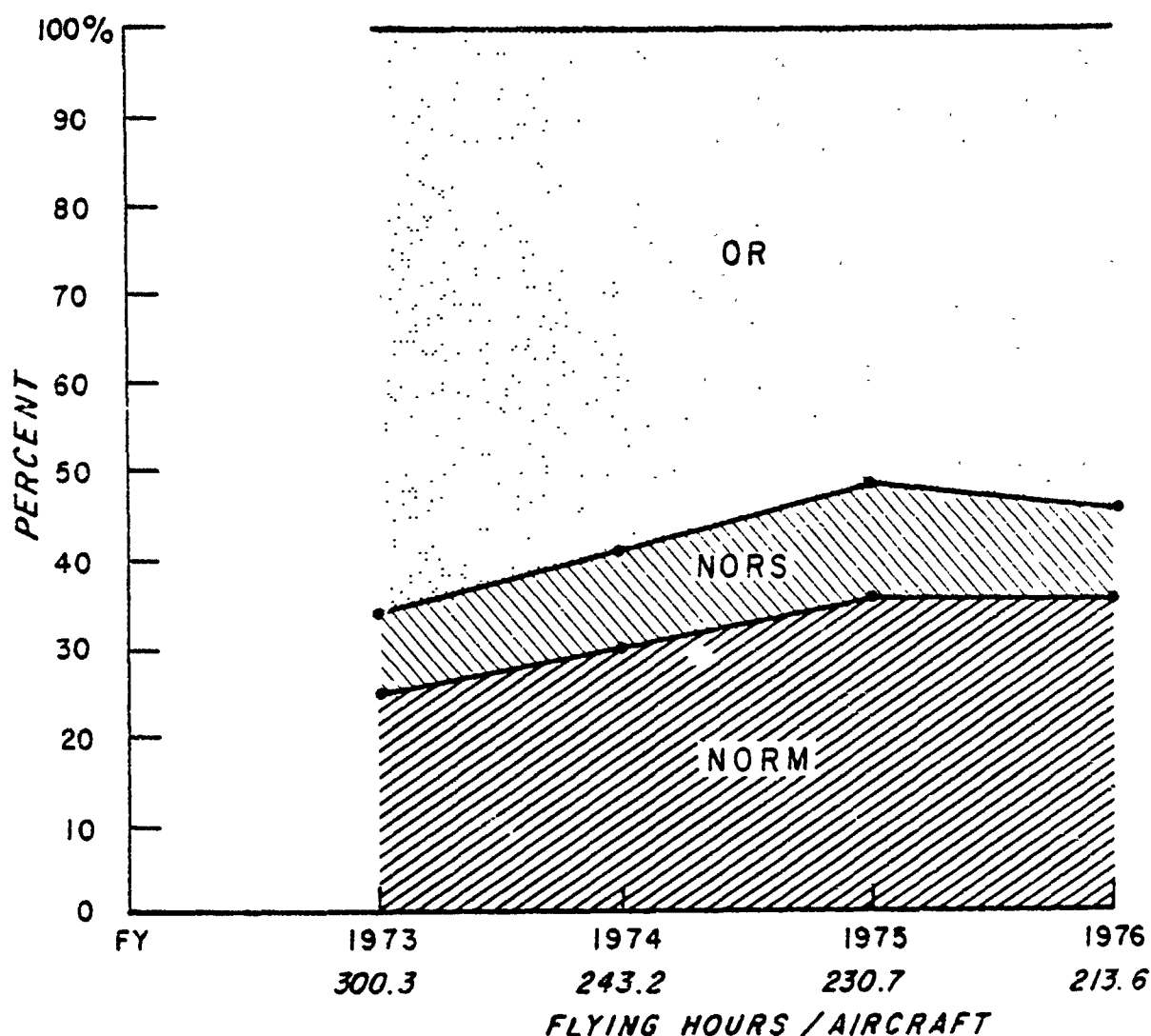
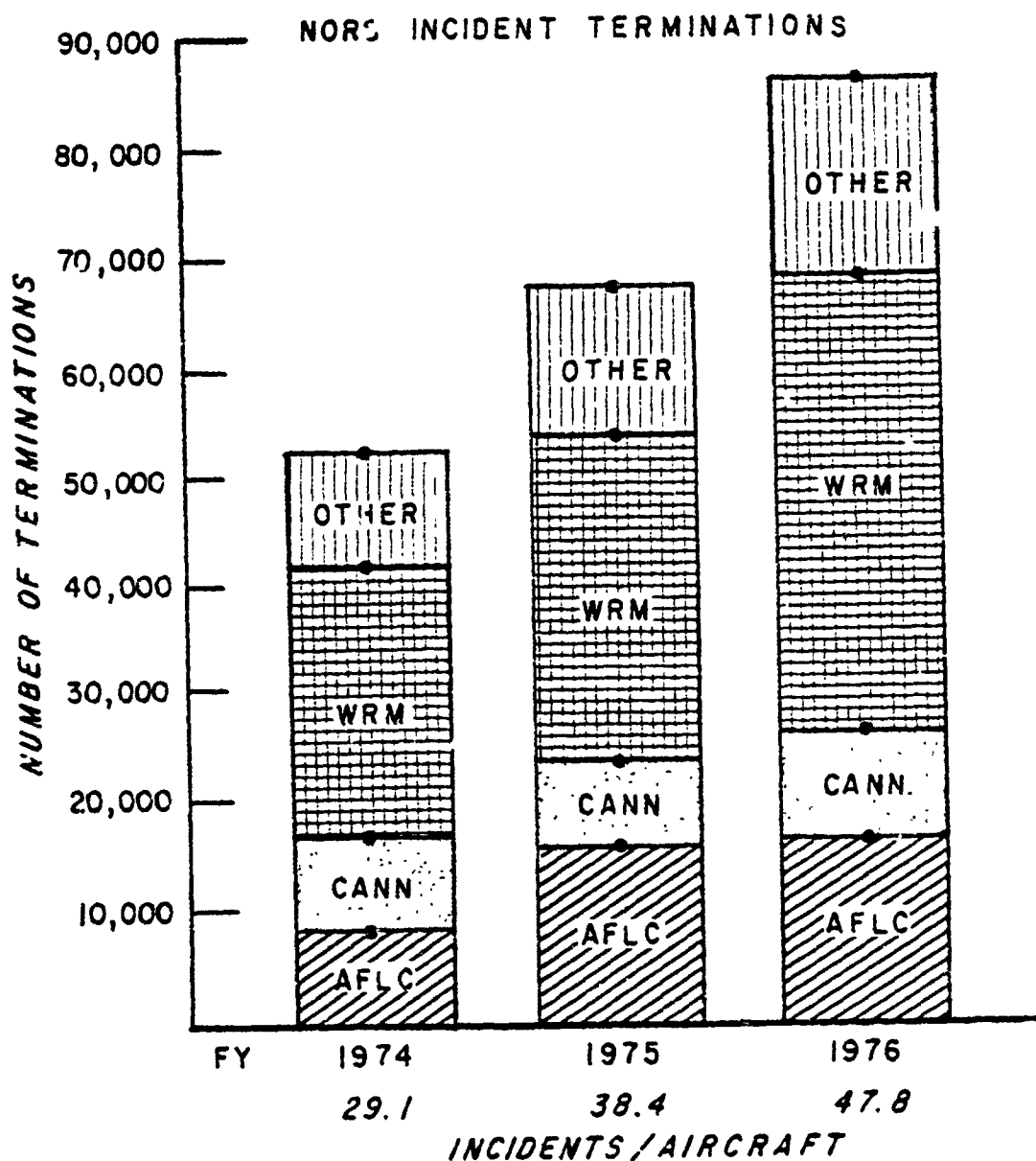


Figure 7 shows the number of F-4 NORS incidents and the methods used to terminate them. The stable NORS rate, despite the increased number of incidents over the three-year period depicted, can now be explained by the

FIGURE 7. F-4 NORS INCIDENT TRENDS



increased use of War Reserve Materiel (WRM) and Cannibalizations (CANN) to terminate the incidents. These methods of termination are quicker, but introduce other problems into overall logistics support. Note that the use of the central supply system (AFLC) to terminate NORS incidents increased only slightly from 1974 to 1975 and not at all from 1975 to 1976.

The direct measurement of materiel readiness through UCMS and MICAP provides a complement to the analytically derived measures needed to establish resource-to-readiness links. For an aircraft like the F-4, the first analytical measure is availability. Availability is derived from the Availability Model portion of LCMS. There is a correspondence between availability and the sum of NMCS and NMCB, or PMCS and PMCB. Furthermore, availability is calculated from the expected number of backorders for spare components to which there is a distant correspondence with NORS (MICAP) incidents.

When fully developed, LCMS will also produce measures of sortie capability, i.e., whether a specified number of sorties can be flown in a given time period. LCOM, which currently performs this function in a somewhat limited form, produces an estimate of the ability to meet a specified flight program given information on hardware characteristics and available manpower and spares. OSD is also currently sponsoring research to project the dynamics of sortie generation in a wartime surge for given resource funding levels. Another effort in development which uses the sortie capability concept is the Air Force Integrated Readiness Management System (AFIRMS). AFIRMS, discussed in more detail in the next section, is envisioned to report, on a day-to-day basis and at the unit level, sortie capability and the resources limiting that capability. All of these efforts have relevance for an aircraft like the F-4.

There are, in addition, other measures which are more remotely related to materiel readiness and hence can be used as "proxy" measures. These include supply fill rates and backorders, maintenance backlogs, and logistics pipeline times. Because these measures are proxy measures, however, caution must be exercised in trying to interpret their implications, particularly in the aggregate. The problem of interpretation is considered in Chapter 6.

DATA COLLECTION AND REPORTING SYSTEMS

We have already mentioned the two DoD-wide reporting systems for materiel readiness, FORSTAT/UNITREP and materiel condition reporting (OR/MC rates). In addition, the individual Services have implemented, developed, or are in the process of developing other data collection and reporting systems which treat materiel readiness in greater depth. We will discuss three such systems: SCIR, RIM, and AFIRMS.

The lack of visibility of resource application needed to provide information for relating resources to readiness is another problem with the reporting systems. The intention of the Logistics Resource Annex (LRA) to the Five Year Defense Program (FYDP) is to help alleviate this problem. All of the reporting systems raise certain questions with respect to the implementation of a DoD-wide readiness management system. We discuss these questions below.

Subsystem Capability Impact Report (SCIR). SCIR, as previously mentioned, extends the mission-capable status reporting for Navy aircraft by identifying those subsystem deficiencies which are contributing to reduced mission capability. Subsystem visibility allows a wider spectrum of missions than a simple Full Mission Capable (FMC) and Partial Mission Capable (PMC) delineation does. Resource requirements can also be more specifically identified. The question raised by SCIR is: What is an appropriate level of

detail for a DcD-wide materiel readiness reporting system? We are inclined to support systems which increase subsystem visibility within each Service, but to allow the Services to report subsystem deficiencies to OSD on a selective basis.

Readiness Indicator Model (RIM). RIM was also briefly referred to in the last section as a model developed by the Army's Concepts Analysis Agency. It is discussed here because it was designed to produce indicators of readiness from aggregate data and hence could serve as a processing mechanism for a readiness reporting system. The measure of readiness used is the difference between authorized and available equipments and personnel. It goes beyond this static concept, however, by projecting deployment/employment delay times. Hence, if an equipment is available in peacetime, yet has a long deployment/employment delay time, it may not be "ready". On the other hand, an unavailable equipment which can meet a deployment/employment deadline may be in a satisfactory state of readiness. RIM is also useful in identifying those resources which are most significant in constraining readiness.

RIM has not been implemented by the Army and there are no plans to do so. The official reason given for not implementing it is lack of staffing. While the run times for RIM are very short and it requires relatively small computer capacity, the aggregate input data must be manually prepared before being useful.

One important question raised by RIM is: How representative are the assumptions which must be made to accommodate the aggregate input data used? For example, the levels of logistics support external to a combat unit are not modelled; they are assumed to be at some constant value. We regard the RIM concept of looking at a dynamic measure which reflects a wartime responsiveness and capability, and at resources as constraints on capability, as a

move in the direction needed. New methods of aggregation, however, need to be developed and evaluated.

Air Force Integrated Readiness Management System (AFIRMS). AFIRMS is currently under development in the Air Force. The plan is to incorporate a dynamic concept of readiness in terms of a sortie capability over some specified period of time. Furthermore, sortie capability is to be assessed in terms of selected resource constraints, e.g., munitions, trained aircrews, and POL (petroleum, oil, lubricants). To perform the calculations, the Air Force is at present planning to use the FOCAS (Forces Capability Assessment System) algorithms. A prototype AFIRMS is expected by the fourth quarter, FY80, and will link the Air Staff with at least one Tactical Air Command wing.

AFIRMS is a very ambitious undertaking which will involve the implementation of a new reporting system in the Air Force. The FOCAS algorithms will be applied at the unit/base level and in so doing will circumvent some of the problems of aggregation. One question which arises with the use of any method of analysis is with respect to the implicit assumptions of the algorithms used. An even more important question, however, is: Can a system, as sophisticated and detailed as AFIRMS is envisioned to be, remain viable at a reasonable cost? That is, can the reliability and timeliness of the information reported be maintained on a continual basis?

It is too early to draw conclusions about AFIRMS. In our opinion, the concept is valid and the project should be continued. AFIRMS provides a wartime output measure that is a step ahead of the RIM measurement concept. The algorithms and the method of implementation should be closely scrutinized, however. If, in the process of implementation, problems of cost or intractability surface, less aspiring alternatives might be considered. Rather than processing data on a day-by-day basis at the local level, for example, unit/

base level data could be sent to a central processing point on a monthly or quarterly basis. Unit/base level integrity would be maintained and the information would be sufficiently timely for programming and budgeting purposes. Such a system would not, however, meet the requirements of operational commanders for day-to-day readiness information.

Logistics Resource Annex (LRA). The LRA, when implemented, will identify projected resource allocations by the categories shown in Table 2. Current OSD plans for the LRA also call for the identification of selected resources to specific weapon systems. If the impact of resources on materiel readiness, as we have defined it, is to be determined, this increased visibility of resource application and allocation (by weapon system) is an important building block. One of the problems with tracking resources has been that the financial reporting systems that contain the needed data are developed and used by offices which perform accounting functions. The objectives and needs of these offices, however, is quite different from those of the analysts and econometricians who "analyze" readiness. The question raised by the LRA concept is: How will the data be used?

The LRA is the means proposed by OASD (MRA&L) for identifying aggregate resource application or projected resource allocations for the support of a specific weapon system like the F-4. To perform readiness analyses with these resource data, asset level and activity level information would also be required. There are numerous reporting systems which can support these data requirements. AFIRMS and models which calculate sortie generation rates must also use such data. These systems do not exhaust the available asset and activity level information, but many important logistics factors and relationships are included. Backorders in the supply system and backlogs in maintenance are particularly relevant.

Our thoughts on the direction that DoD materiel readiness measurement and reporting systems should be moving necessarily overlap with our thoughts on analytical tools to be discussed in the next section. They include the following:

- expansion of the scope of MC/OR reporting systems to increase the visibility of subsystem deficiencies (e.g., SCIR), for use primarily within the Services;
- development of systems which derive output measures of wartime capability (e.g., aircraft sortie generations), and treat the dynamics of that capability where appropriate (e.g., AFIRMS);
- development of systems which derive improved measures of responsiveness (e.g., aircraft availability) through a model of logistics support relationships (e.g., the Availability Model portion of LCMS);
- development of systems to support the LRA;
- identification of resources as constraints on capability (e.g., RIM, AFIRMS); and
- maintenance of unit/base integrity with respect to asset and activity level data.

The last two recommendations above are intended to circumvent some of the problems of aggregation. By processing unit/base level data through a set of algorithms or a model and identifying resource constraints at that level prior to aggregation, the loss and distortion of information as a result of aggregation should be minimized. We believe that future development of data collection and reporting systems should be integrally linked with the development of analytical tools.

ANALYTICAL TOOLS

Some analytical tools have already been briefly discussed in the context of measurement and reporting systems. This section focuses on the characteristics of these and other tools that can assist management in evaluating the impacts of resources on materiel readiness. These tools include a broad spectrum from the totally qualitative to the highly mathematical. The requirements of public law specify quantitative results; therefore, this section is

devoted to quantitative tools. All quantitative tools, of course, possess some underlying qualitative structure, and a structural framework alone can be valuable in organizing and better understanding the many relationships manifest in logistics support, and therefore assist in better articulating questions about resource impacts. This topic is discussed further in Chapter 6.

Following the lead of a study group at George Washington University,³ we have identified three broad classes of quantitative tools:

- hierarchical indexing;
- statistical data analysis; and
- theoretical models.

We choose to divide theoretical models into two categories to distinguish the Monte Carlo simulation model from other types of formal model. There are numerous examples of each of these types of tools; we select only a few to discuss here.

Hierarchical Indexing. One way of structuring the elements of a system, particularly very complex or abstract systems, is with a tree or hierarchy. To quantify that structure requires indexing or scaling the elements of the hierarchy. In most applications of this method of quantification, the indexing is primarily a subjective process. The method suffers not only from the problems of subjectivity, but also from other methodological problems with the mathematical assumptions generally made. In some management decision-making situations, however, particularly those which other types of tools can not accommodate, hierarchical indexing could prove to be a useful means for delineating issues and establishing preliminary priorities.

³ Zeev Barzily, W.H. Marlow, S. Zacks, Survey of Approaches to Readiness, Institute for Management Science and Engineering, Program in Logistics, George Washington University, Serial T-364, 10 November 1977.

A good example of hierarchical indexing was the Navy sponsored METRI project in the early 1960's.⁴ METRI was an attempt to establish a readiness index for a ship by indexing the ship's subsystems with respect to reliability and spares availability, and then aggregating to an overall index for the ship.

A more recent example is an application to the relationships between funding and force readiness in U.S. Army, Europe (USAREUR).⁵ Readiness is subdivided into seven mission-related categories: training, personnel, logistics, life support, operational facilities, communications/command/ control, and weapon systems/equipment. The types of unit considered include: mechanized infantry, armor, divisional cavalry, nondivisional cavalry, field artillery, divisional air artillery, nondivisional air artillery, engineer, and signal. These basic elements may be further divided into subelements, and subelements into nodes. A common unit of measurement or index is applied to the nodes at the bottom of the tree. The indices are then aggregated to arrive at indices for mission categories and for overall readiness. Resource shortfalls are indicated by the values assigned at each node.

Another application of hierarchical indexing has been by the Air Force in Mission Area Analysis (MAA). The intent of MAA is to provide guidance for allocating resources in accordance with mission priorities. Specific tasks for developing desired capabilities are assigned weights which reflect their degree of need. The Army is now conducting an MAA study of its own. The study group intends to use the Air Force software and apply it to designated Army missions.

⁴Dunlap and Associates, "METRI Pilot Program Report, USS Ellison", DD-864, Darien, Conn., 1964.

⁵Maj. Gen. Elton J. Delaune, Jr., Daniel Nussbaum, and C. James Desmartin, "Establishing the Army's Funding-to-Readiness Relationship in USAREUR", Defense Management Journal, May-June 1979, pp. 4-9.

Statistical Data Analysis. Many analysts prefer tools which operate directly on readiness and resource data. The objective of this form of analysis is to identify patterns in the data and to infer relationships from the patterns. The techniques used are generally statistical, i.e., regression analysis, factor analysis, correlation analysis, etc. The argument behind using this type of tool is that "real world" data are required to properly expose the complexities and subtleties of the relationships. The assumption, however, is that the patterns which occurred in the past will continue to be manifest in the future; and if trends are observed in historical data, forecasting techniques can be used to project future patterns. While these assumptions are open to serious question, statistical techniques are still useful for many purposes.

One of the best examples of statistical data analysis we reviewed involved the development of relationships between selected resources and indicators of ship readiness. Readiness data from five sources were used--Maintenance and Material Management System (3-M), Casualty Reporting System (CASREPT), Naval Force Status System (NAVFORSTAT), Board of Inspection and Survey (INSURV), and Propulsion Examining Board (PEB). Regression analysis yielded positive correlations, but a substantial amount of variance was left unexplained.⁶ Another study attempted to characterize the readiness of Navy ships by applying data reduction techniques to Operational Readiness Inspection (ORI) data. Principal component analysis, factor analysis, and clustering methods were used to classify ships into groups representing relative degrees of readiness.⁷

⁶Stanley A. Horowitz, et al., The Material Condition of Ships and its Improvement (Surface Ship Maintenance and Supply Study), Center for Naval Analyses, CNS 1111, January 1979 (Confidential).

⁷Zeev Barzily, W.H. Marlow, S. Zacks, Readiness Evaluations Using Multivariate Data Reduction, Institute for Management Science and Engineering, Program in Logistics, The George Washington University, Serial T-385, 1 November 1978.

The state of the art in pattern recognition techniques is growing rapidly. Some of these techniques may prove superior to the traditional statistical techniques. The development of these techniques, should, therefore, be closely monitored; at present, however, statistical techniques represent the state of the art in resources/readiness data analysis.

Monte Carlo Simulation Models. The development of theoretical models is defended on the basis that analysis of relationships in a system requires an identification of the structure of the system. Once the structure of a model has been specified, historical data can often help validate the assumptions of the model; however, historical data are not regarded as particularly useful initially in identifying model structure. When the relationships between the variables in a model involve probability distributions, random sampling of the distributions using Monte Carlo methods is often an efficient modelling technique. Many Monte Carlo simulations, however, are large and require long run times. These models tend to be costly and time consuming to develop. Logistics system simulations tend to fall into this category.

The Navy's TIGER model and the Army's ARMS (Aircraft Reliability and Maintainability Simulation) model are examples of Monte Carlo simulations which have been used in assessing the design and support characteristics of weapon systems. The Air Force LCOM model is used to determine the manpower and spares levels required to achieve a specified sortie capability. The model is very large, incorporating many variables, e.g., weather, crews, attrition rates, munition loads, facilities, failure rates, job durations, sortie profiles, etc. The run times on LCOM are long, but it is still used for annual manpower planning. As previously mentioned, there are plans to interface LCOM with the Aircraft Availability Model for purposes of comprehensive spares planning.

Other Theoretical Models. Models that do not use Monte Carlo methods rely on analytic solution techniques. These models treat relationships between variables in closed mathematical form. Probability distributions may also be incorporated in these models; but rather than randomly sampling a distribution, the model extracts characteristics of the distribution, e.g., its expected value, and performs calculations with those characteristics. Central support planning--spares and depot repair allocation, in particular--lends itself well to analytic modelling techniques (e.g., the Aircraft Availability Model). Intermediate and organizational-level support models often require the use of Monte Carlo methods (e.g., the Sortie Generation Model and the Armored Unit Readiness Assessor, currently under development). One explanation is that modelling at the intermediate and organizational levels requires a dynamic, output orientation, whereas steady state assumptions are often acceptable for central support modelling.

The Aircraft Availability Model portion of LCMS uses a marginal analysis approach to determine the optimal tradeoff between depot component repair and spares procurement for a particular aircraft MD (Mission Design) and for a given availability level. Preserving the autonomy of aircraft by MD allows the user of the model to consider the relative importance of the aircraft with respect to their missions in evaluating budgetary options.

The type of information generated by the Availability Model is shown in Table 3. The user is presented with the optimal budgetary implications of alternative availability levels expressed both in percentage and number of aircraft available. Furthermore, the quantity of particular spares that should be procured or scheduled for repair are determined for each availability level. The user can also specify a dollar ceiling for spares procurement or depot repair, and the model will give him the effect on availability level.

TABLE 3. TYPE OF INFORMATION GENERATED
BY AVAILABILITY MODEL*

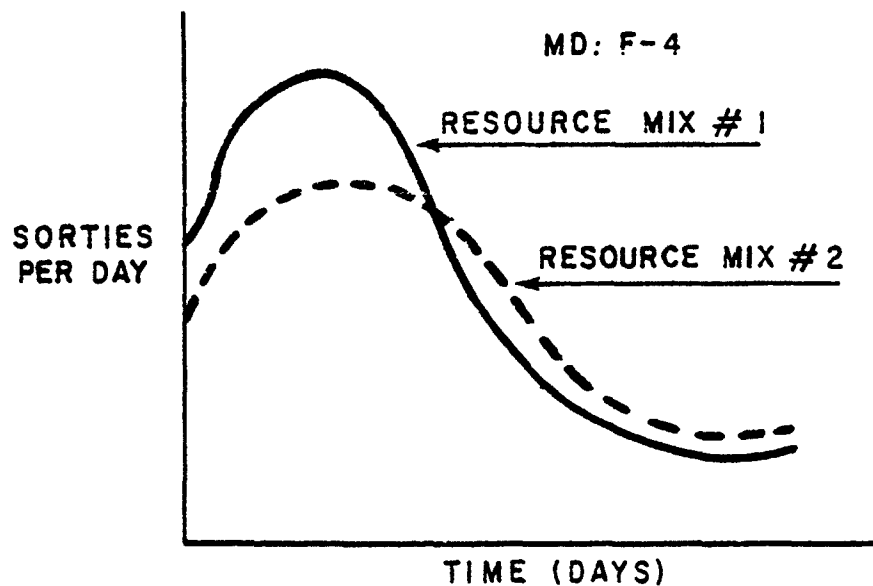
MD: F-4

<u>% Availability</u>	<u># Available</u>	<u>Depot Component Repair \$</u>	<u>Spares Procurement \$</u>
95%	190	\$ 60M	\$ 50M
90%	180	\$ 45M	\$ 38M
85%	170	\$ 35M	\$ 29M
80%	160	\$ 27M	\$ 24M
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.

* Numbers are hypothetical.

A study is currently underway to extend the capability of the Availability Model for the purpose of evaluating maximum sortie rates. The model will use queueing mathematics to generate maximum sortie profiles as depicted in Figure 8. To generate these profiles, assumptions are made for attrition rates, repair times, work schedules, and other variables. Use of war reserve materiel and cannibalization is also assumed. The model uses Monte Carlo techniques but is much smaller in size than models like LCOM. Eventually the model will allow assessment of alternative resource mixes and assumptions. As in the AFIRMS concept, the model will operate at the unit/base level. To allow Air Force-wide assessments, a distribution model is being developed to account for variations in the resources available to individual bases.

FIGURE 8. AIRCRAFT SORTIE PROFILES



In research sponsored by OSD, RAND has used a similar approach for Army combat units. The model employed (Armored Unit Readiness Assessor--AURA) is also a Monte Carlo simulation. The output is a profile of platoon attacks per day, given certain assumptions. Both sortie and platoon attack generation models can potentially be useful in identifying which resources represent the binding constraints on capability. In OSD policy and resource allocation decisions, access to this type of information is more important than precise information on predicted sorties/platoon attacks. Sortie/platoon attack generation capability is simply a readiness indicator useful in assessing alternatives.

As mentioned in the previous section, the analytical tools needed to relate resources to materiel readiness overlap with the needs for measurement and reporting systems. In particular, a combination of tools is needed. This approach permits visibility of a greater variety of measures, assumptions, and relationships. We would, however, place emphasis on modelling approaches wherever possible, complemented with some data analysis. Data analysis is particularly valuable during the validation phase of model development. We would use hierarchical indexing techniques only as a last resort. These techniques may, however, be the only ones appropriate in certain circumstances; and even though they may possess numerous methodological flaws, hierarchical techniques can serve a valuable pedagogic purpose.

In addition to the thoughts we expressed for measurement and reporting systems, general guidance we can offer with respect to model development includes:

- very large models should be avoided if at all possible, as they tend to be expensive, to involve long run times, and to have unrealistic data requirements;
- model assumptions should be succinctly stated and visible to both the users of the model and the users of the output;
- models are needed which produce a wartime output, a dynamic wartime output if appropriate;
- models oriented to identifying resource constraints are particularly useful for aggregate, resource allocation decision-making.

The discussion in this chapter has, for the most part, focused on tools used by, or under development within, the Military Departments. Under our concept, these tools will remain under the cognizance of the respective Services, with OSD being the recipient of the appropriate output only. A relevant question is: Are there management tools that OSD itself could use once it has received the inputs of each Military Department? The OSD-sponsored studies on aircraft sortie generation capability and armored platoon

attacks were intended to serve this purpose. Any set of quantitative models used by OSD, however, will inevitably have to be supplemented with sound qualitative evaluation. The process of integrating and evaluating information from a number of different sources is discussed in Chapter 6.

READINESS EXERCISE RESULTS

A readiness exercise is generally the one time when a weapon system is in peacetime stressed to its wartime capabilities. As such, exercises are a source of potentially valuable information for measuring and relating resources to readiness. Unfortunately, readiness exercises are very expensive and it is often difficult to simulate wartime conditions. Exercises are usually conducted for a short period of time relative to a possible wartime engagement. Furthermore, the first priority in readiness exercises is the successful completion of assigned missions. Documentation of the effort is of secondary importance. Hence, while an exercise provides an excellent opportunity for collecting information on logistics support problems and constraining resources, and for doing so through relatively "objective" observers, the feasibility of such needs to be evaluated.

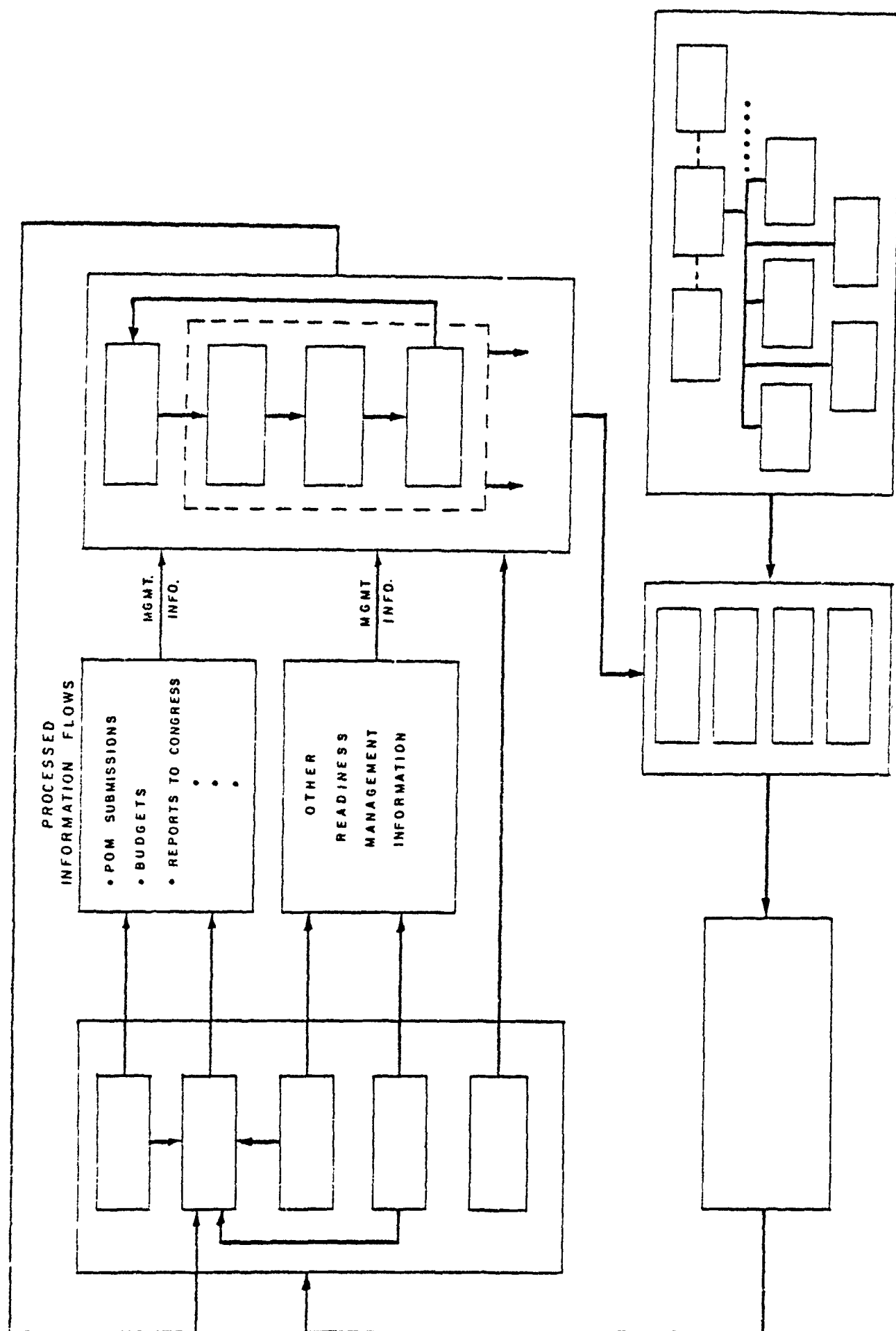
The results of readiness exercises would be particularly useful for validating models and evaluating the assumptions behind the models. They would also assist in identifying specific readiness deficiencies. We recommend that the feasibility of increasing the visibility of support resources and their impacts during readiness exercises and of reporting the results to a central DoD location be determined. While the various limitations inherent in readiness exercises as discussed above may preclude this as a worthwhile part of a DoD-wide readiness management system, the potential value of rigorously designed and analyzed exercises is deserving of management attention.

5 FORMALIZATION OF INFORMATION FLOWS

The responsibilities of DoD readiness management require that certain information be available on both a periodic and an ad hoc basis. In OSD these information requirements include supporting documentation for the POM, the budget, and the annual readiness report to Congress (see Figure 9). At present, these forms of information are very different. With the identification and development of information sources (e.g., reporting systems, readiness exercises, and models), these forms of information should begin to converge. That is, the projections of readiness based on requested funding levels, as required in the annual readiness report to Congress, is the same type of information that should be useful in evaluating resource allocation decisions during the programming and budgeting process.

At present, the annual readiness report to Congress includes current and projected readiness rates and inventory objectives for an exhaustive list of weapon systems and equipments. Readiness is measured in terms of OR/MC rates or asset readiness objectives. While Congress has asked that readiness requirements be included for each weapon system, this is not done for all weapon systems. The Air Force does not include any requirements. Their argument has been that requirements or standards established for measures like OR/MC rates are not meaningful and can be misleading. With respect to many weapon systems (e.g., aircraft, ships), we agree with the Air Force position. Readiness requirements for missiles and other munitions, however, are probably useful. The relationship between the process of establishing readiness requirements and the resource allocation process needs to be better understood. We suspect that the separation of these processes can lead to

FIGURE 9. OVERVIEW OF MANAGEMENT CONCEPT: INFORMATION FLOWS



inconsistencies and less than optimal decisions in both the establishment of requirements and the allocation of resources.

POM and budget information is submitted in terms of appropriation and resource categories. The resource categories regarded by OSD as directly relevant to the materiel readiness of aircraft are:

- initial spares;
- replenishment spares;
- engine procurement;
- reliability and maintainability modifications (R&M Mods);
- depot component repair;
- engine rework;
- aircraft overhaul;
- war reserve materiel;
- stock fund items;
- base maintenance personnel; and
- a portion of base operating support.

These resource categories correspond roughly to categories used in the POM and budget and to the LRA structure. The LRA, however, proposes to identify appropriate resources to specific weapon systems.

Resource categories can be evaluated separately or in groups, depending on the degree of interdependence and the analytical tools available. The Aircraft Availability Model previously discussed, for example, treats spares procurement and depot component repair together (see Table 3, page 4-26). That model is currently being extended to consider engine procurement and repair as well. Aircraft overhaul is a very difficult area, as it is not clear what impact an overhaul has on materiel readiness. The need for engineering changes and rework generally determine funding for this resource

category. To treat war reserve materiel properly requires an assessment of a dynamic wartime sortie capability. Funds for base maintenance personnel generally fall under the purview of manpower planning rather than logistics planning. Stock fund items are not well treated in the programming process, in part due to the complex financial reporting systems which support the stock funds. The base supply, transportation, and administration portions of base operating support also present problems. It is difficult to trace these resources directly to their impact on aircraft materiel readiness.

R&M Mods are generally treated as a separate resource category. The Air Force attempts to manage aircraft modifications by maintaining an up-to-date list of components which are candidates for modification. Those components which offer the most potential for improvement are evaluated to determine the feasibility of incorporating a modification. A prioritized list of modifications results. Many modifications, however, are not designed to improve reliability and maintainability, but rather to enhance aircraft performance or correct safety problems. Sometimes reliability and maintainability improvements are fallout benefits of modifications intended for other purposes. The point is that tracking the impact of R&M Mod funds to aircraft availability and materiel readiness is not a straightforward task. The Air Force has attempted to do just that by collecting aircraft data over a period of time after the installation of a mod. These efforts have not been very successful.

Our concept calls for information formats to accompany the POM submissions to OSD and the annual readiness report to Congress. There would be separate formats for each resource category or group of resource categories. What the best groups of resources are and what information can and should be submitted on them are questions that need to be resolved.

Figure 10 represents the information which might be included in an "ideal" format for R&M Mods, in this example, for the F-4. Weapon system integrity is maintained. Since there is currently no model for determining the optimum funding for R&M Mods, a list of candidate mods is included. The candidates are ordered with respect to the estimated change in availability (or other measure of materiel readiness) divided by the cost of the modification. Projected changes in reliability, maintainability, and availability are also included. If the benefit of the mods would be derived in other forms, e.g., reduced support costs, this must also be considered. This format allows a decision-maker to perform marginal analysis. For a requested or given funding level, represented by the line across the middle, mission-capable status is projected and compared with recent mission-capable status. Since R&M Mods are being treated as a separate resource category, only the effects resulting from funding in this area should be reflected in the projected availability and mission-capable status. It may also be appropriate to include a sortie generation profile showing the expected change resulting from R&M Mod funding.

Again, this is only a sample information format presented to illustrate our concept. The specification of the precise details of the information to be included requires research and negotiation. The feasibility and reliability of the analysis required to provide the information specified must be determined. Furthermore, readiness criteria other than those we have mentioned (availability, mission-capable status, sortie capability) may be more important in some resource allocation decisions. As the methods for analyzing and managing resources and the processes for establishing readiness requirements are better understood, new ideas for information formats may emerge.

FIGURE 10. SAMPLE INFORMATION DISPLAY FORMAT

RESOURCE CATEGORY: R&M MODS

WEAPON SYSTEM: F-4

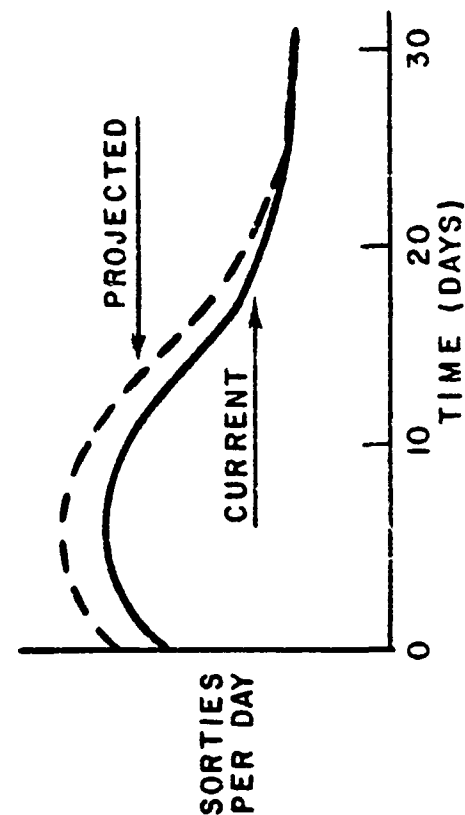
MOD	COST	PROJECTED CHANGE IN W/S RELIABILITY	PROJECTED CHANGE IN W/S MAINTAINABILITY	PROJECTED CHANGE IN W/S AVAILABILITY
=====	=====	=====	=====	=====
=====	=====	=====	=====	=====
=====	=====	=====	=====	=====
=====	=====	=====	=====	=====
=====	=====	=====	=====	=====
=====	=====	=====	=====	=====
=====	=====	=====	=====	=====
=====	=====	=====	=====	=====
=====	=====	=====	=====	=====

LEVEL OF R&M MOD FUNDING

PAST YEAR: FMC _____
 (WITHOUT
 PROPOSED
 MODS) PMC _____
 NMC _____

→ PROJECTED: FMC _____
 (WITH
 PROPOSED
 MODS) PMC _____
 NMC _____

REMARKS:



6. EVALUATION OF POLICY AND RESOURCE ALLOCATION DECISIONS

One of the themes that consistently emerged in our discussions with DoD officials with respect to this task was the scope of the endeavor. There are so many factors involved in managing readiness and so many relationships among them that one tends to feel caught in a maze of information. This fact alone presents serious problems in applying sound managerial judgment in the allocation of resources, as well as in developing analytical tools to assist in the process. These difficulties are particularly worrisome to an administrator relatively new to defense.

In this chapter, we discuss some of the factors involved in the link between resources and materiel readiness and attempt to structure the relevant relationships qualitatively. This is a necessary step in facilitating the transfer of institutional knowledge⁸ across readiness-related functions and organizational levels, and in providing continuity when new personnel assume DoD positions with policy and resource allocation responsibility. Furthermore, it provides a means for better understanding and evaluating the assumptions underlying available and proposed analytical models, and articulating questions about them.

While such structures would seem relatively straightforward to formulate, we found little evidence that this is done. Many logistics managers are familiar with a particular aspect of logistics, e.g., supply, maintenance, or

⁸By institutional knowledge we are referring to the unstructured repository of information made up of the technical background, experience, and judgment possessed by managers at all levels in DoD. It is an extremely important and heavily relied on source of information for OSD decision-making. Any formal DoD management system should take advantage of this form of information.

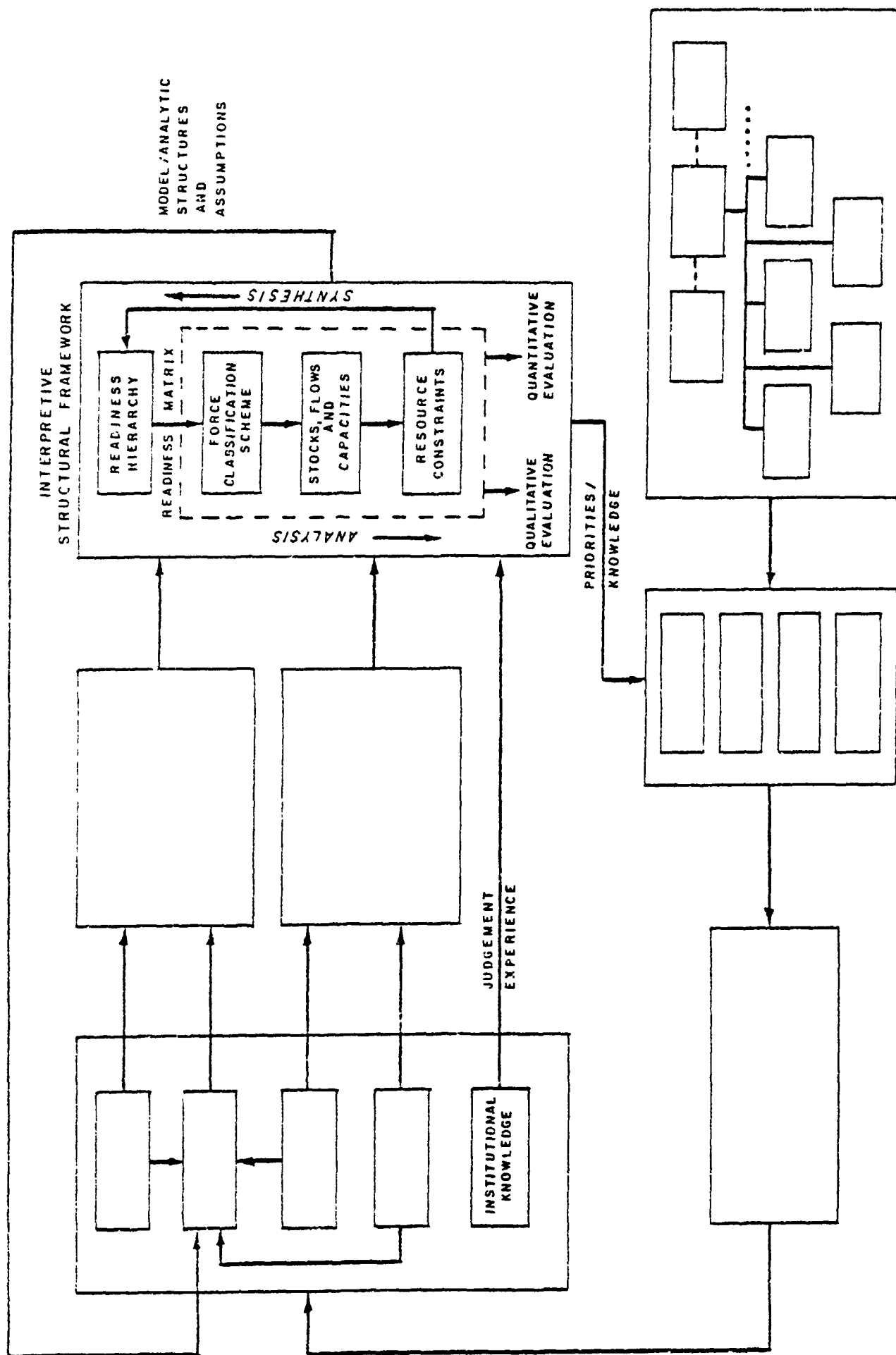
transportation, but fewer are familiar with all aspects and how they are interrelated. An understanding of the logistics system as a whole is essential for making judgments with respect to the relationships between resources and materiel readiness.

Providing structure to the information received from numerous and diverse sources is the role of what we refer to as an interpretive structural framework. This framework allows an administrator to organize the factors and measures involved in readiness management and to evaluate the implications of alternative decisions for purposes of policy formulation, resource allocation, defense planning, and research coordination. While much of the evaluation must of necessity be qualitative in nature, the existence of a structural framework is also a necessary precursor to quantitative evaluation. The elements of our concept of a structural framework are shown in Figure 11.

The concept of the structural framework is the most difficult aspect of the proposed management system to explain. The point is that the more structure given to management information, the greater the analytic and evaluative capacity of the user of that information. Examples of useful structures include decision trees or hierarchies, process flow charts, and matrices, all of which we propose to use. These structures could also provide the basis for a policy-level decision support system.

The first element of the structural framework is the hierarchical structure of the readiness taxonomy discussed in Chapter 2. This structure allows one to place specific aspects of readiness (e.g., materiel readiness) into the context of total force readiness, DoD capability, and overall military effectiveness. If the "big picture" is not kept in mind while formulating policy and allocating resources, the decisions made may be less effective and not in the "best" interests of national defense posture. There are techniques for

FIGURE 11. OVERVIEW OF MANAGEMENT CONCEPT: STRUCTURAL FRAMEWORK



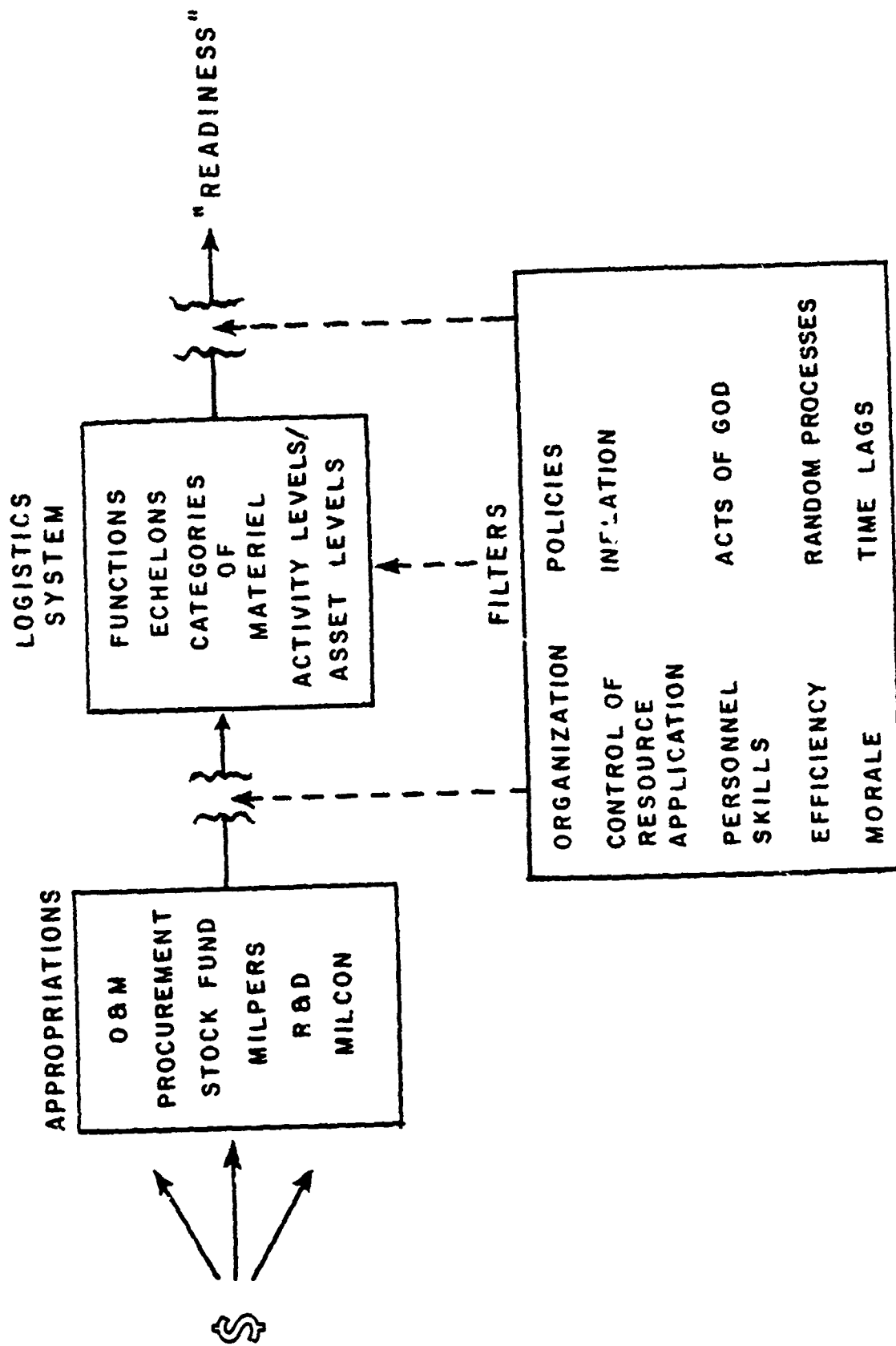
quantifying a hierarchical structure, but at present we believe the value of the hierarchy is primarily qualitative.

The second element of the structural framework is a force classification scheme. We believe that the measurement, reporting, and analysis of readiness will vary for different force types, missions, and/or functions. That is, measures of readiness for Air Force tactical aircraft will not be the same as measures for Navy surface combat ships. Likewise, the methods for analyzing the impacts of resources on readiness will differ. We recommend that an appropriate classification scheme for force types, missions, and/or functions be developed. This classification would provide the building blocks for an assessment of overall force readiness.

The third element of the structural framework is the structure of the stocks and flows of materiel and personnel, and the capacities of logistics, personnel, training, and operational facilities. As depicted in Figure 12 for materiel readiness, this structure provides the links between resources and asset levels/activity levels, and between asset levels/activity levels and the readiness of a particular force type. The relationships between resources and materiel readiness are determined to a large extent by the structure and operation of the logistics systems. These systems can generally be conceptualized in terms of echelons of support and logistics functions. The internal relationships can be characterized by stocks and flows of materiel, i.e., asset levels and activity levels. Asset and activity level information on materiel support and aircraft operations is, then, very relevant to relating resources to readiness, and most models which we would recommend are structured in terms of these stocks and flows. One of the problems with data on these factors, however, is that the high levels of aggregation desired are difficult to achieve without introducing significant distortion and loss of content.

FIGURE 12.

COMPLEXITY OF THE RESOURCES - TO - READINESS RELATIONSHIP



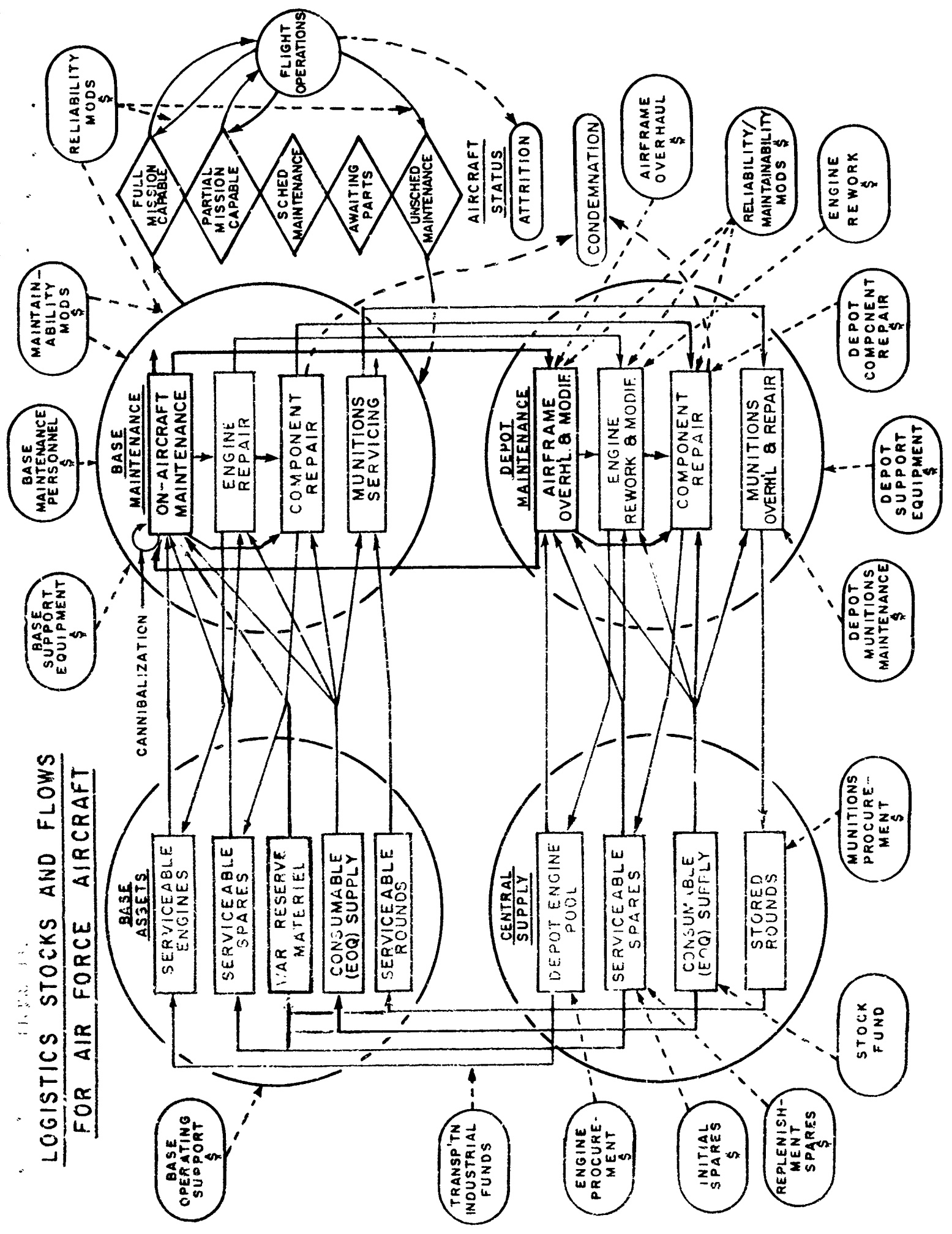
In addition to internal logistics structure and operations, there are many external factors and many policies that determine how resources are utilized and further constrain activity levels. Some external factors include order-and-ship times, procurement lead times, personnel skill levels, and inflation. Some relevant policies include stockage policies, provisioning policies, maintenance policies (e.g., NRTS⁹, scheduled maintenance, overhaul), personnel policies, and forecasting policies. All of these factors tend to act as filters that render unclear the impact of resources on readiness.

One of the most complicating of these filters is the effect of time lags on the resources-to-readiness relationship. The length of time it takes to realize an impact on readiness is different for different resource categories. Furthermore, the impact may be highly uncertain or it may be distributed over an extended period of time. Conflicts with respect to the value or cost attributed to time lags, uncertainty, and the flow of benefits over time are inevitable.

Figure 13 is a diagram of a simplified version of a structure for the stocks and flows of materiel in the logistics support cycle for Air Force aircraft. Not all factors are included, but the complexity of the interrelationships between the stocks and flows which are included should be apparent. This structure distinguishes logistics functions (supply, maintenance, and transportation), support echelons (base and depot), and categories of materiel (airframes, engines, recoverable components, consumable components, munitions, and war reserve materiel). Support personnel and support equipment are simply treated as resources. Each colored arrow corresponds to the flow of a particular class of materiel. Assets accumulate at the various depot and base locations. Resources are allocated to increase

⁹Not Repairable This Station.

LOGISTICS STOCKS AND FLOWS FOR AIR FORCE AIRCRAFT



stock levels or maintenance activity levels. These resources are indicated by the dotted arrows impacting on the logistics or flight activities. Aircraft status is depicted in terms of mission capability; the ultimate output is flight operations, measured in terms of sorties or flight hours. The entire support structure affects the capability of a unit to perform flight operations. These flight operations may be very different in peacetime than in wartime, depending on what limitations are placed on them in peacetime. Diagrams like this can be useful in evaluating the structures and assumptions of models and analytical techniques that link resources to readiness. These diagrams need to be developed for all force types, missions, and/or functions and for both materiel and personnel.

The final element of the structural framework treats resources specifically. The need for this element arises from the problems of aggregation. If resources are to be aggregated to the degree required by OSD and the policy levels of the Military Departments, they need to be treated as constraints on readiness. The probability of developing strictly functional relationships between aggregate resources and readiness is not promising. By treating resources as constraints and identifying the binding constraints, the process of synthesizing the readiness of individual units into a DoD readiness posture can be carried out without losing the synergistic effects that exist among the resources and factors involved. Unless the basing structure is relatively homogeneous, however, these resource constraints must be identified for each unit at each base. In addition, resources not assigned to bases, but available in the event of an emergency must be included in an overall estimate of DoD readiness. However, this form of analysis is limited by the availability of appropriate resource data and by the state of the art in resource modelling. We recommend that new methods be developed to deal specifically

with resource fungibility (e.g., labor vs. capital), uncertainty in resource demands (e.g., petroleum prices), and the need for flexibility in resource application in order to respond to unanticipated economic, technological, or international circumstances.

The value of developing qualitative structures of the type proposed here may not be readily apparent, and may be given less attention than other information and analytical needs in readiness management. However, the possibilities are rich for developing innovative displays of these structures. Furthermore, it may be possible at some time in the future to quantify these structures. The point is that the full value of a structural framework has yet to be realized. Two research topics which are particularly troublesome are: (1) the treatment of the dynamics of readiness and of dynamic uncertainty in resource allocation, as previously discussed in the context of readiness measurement and resource structure; and (2) methods of aggregation, as previously discussed in the context of reporting systems and analytical tools. The arrows labelled "analysis" and "synthesis" in Figure 11 relate to the problem of aggregation in policy and resource evaluation.

One use of this structural framework is to provide a basis for matrices of force types, readiness measures, resources, measurement/reporting systems, and analytical tools. A matrix can be a very valuable tool for organizing information in a data base. In the next chapter we propose applying such a matrix to the development of a detailed long-range plan for a DoD readiness management system. The structural framework will be used to characterize readiness reporting systems and analytical tools, and to identify gaps in current management capability to measure and analyze readiness. In so doing, an application of the proposed structural framework will be illustrated.

7. PROPOSAL FOR IMPLEMENTATION

SUMMARY OF CONCLUSIONS

To summarize, the primary conclusions incorporated in our proposed concept are:

- 1) Inconsistency and ambiguity in the use of the word "readiness" and associated terms can be reduced through the promulgation of a readiness taxonomy and list of formal definitions;
- 2) Coordination of readiness management efforts and of readiness-related resource allocation and policy decisions can be improved through the assignment of responsibility for readiness management to specific offices and individuals with top-level visibility;
- 3) In general, ^{Since} no single measure of readiness captures the total meaning of the definition of readiness, Hence, a combination or vector of measures is required in evaluating readiness-related resource allocation and policy decisions;
4. There is a need for output-oriented measures that capture the dynamic aspects of readiness more fully.
5. Indicators of readiness available through current reporting and data collection systems suffer from the problems of aggregation. However, those indicators can be useful in raising specific questions about readiness trends.
6. Models currently used or under development offer great potential for resource allocation decisions; Central support models employing steady state measures of readiness and intermediate/ organizational support level models employing dynamic output-oriented measures of readiness are particularly promising.
7. Rigorously designed and analyzed readiness exercises are potentially valuable sources of information for identifying specific readiness deficiencies. The use of exercises to collect more reliable data should be explored.
8. Development of a policy-level decision support system for readiness management requires that the information available from the various sources be meticulously structured in terms of force types, weapons systems, and missions; stocks and flows of materiel and personnel; and appropriately aggregated resource categories.

TOTAL MANAGEMENT CONCEPT

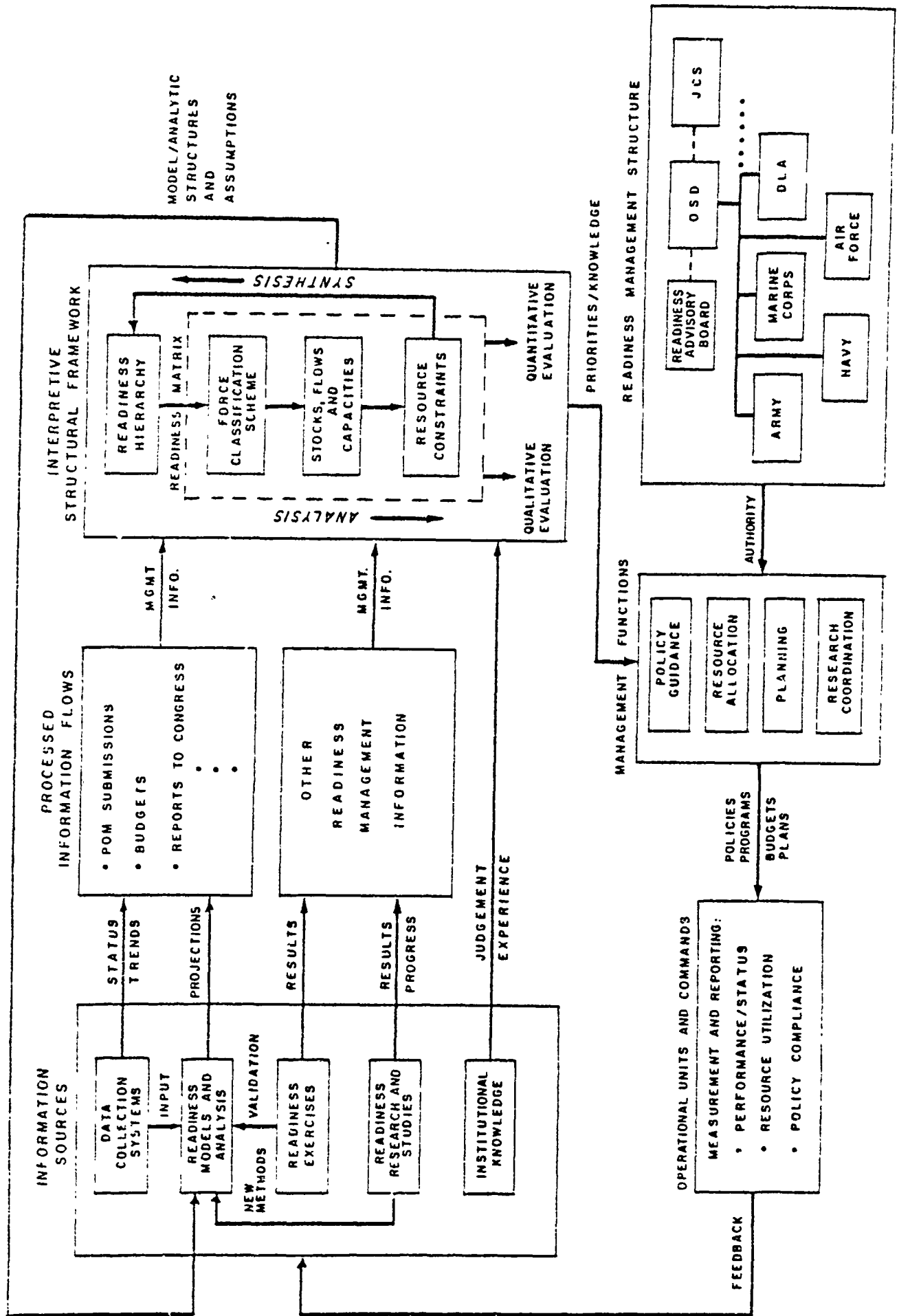
The total concept establishes a direction for the improvement of readiness management in the DoD. Its successful implementation requires that resource allocation and policy decisions be explicitly oriented toward impacts on force readiness, capability, and military effectiveness. Figure 14 provides an overview of our total concept for readiness management. We have proposed a readiness taxonomy; a readiness management structure; guidance for improving readiness measurement, reporting, and analysis; the formalization of information flows; and the use of a structural framework to help interpret management information and evaluate decision alternatives.

Action on some of the aspects of our concept could be initiated immediately. The characteristics of a viable readiness management structure, for example, are relatively firm. Also, numerous measurement/reporting systems and models are under development that are promising from the point of view of improving readiness management. However, more precise specifications for the POM and budget information flows and a more detailed description of the structural framework need to be developed. We believe this development will require introducing new approaches for classifying, clustering, and aggregating support resources, logistics and manpower assets and activity levels, weapon system missions and capabilities, and force operations. In addition, these approaches will undoubtedly have significant implications for current readiness management processes and for the quantitative methods incorporated in readiness measurement, reporting, and analysis systems.

IMPLEMENTATION STEPS

The implementation of the total concept for readiness management must be performed in steps and will require a number of years. Table 4 summarizes the various aspects of the problem as we have identified them, our concept for

FIGURE 14. TOTAL READINESS MANAGEMENT CONCEPT



dealing with each aspect, and the short-term and long-term actions which we propose as implementation steps.

TABLE 4. SUMMARY OF IMPLEMENTATION STEPS

<u>ISSUES</u>	<u>THE PROBLEM</u>	<u>THE CONCEPT</u>	<u>THE PLAN</u>	
			<u>SHORT-TERM</u>	<u>LONG-TERM</u>
Definitions	Ambiguous/ Non-uniform	Hierarchy/ Taxonomy	SecDef Memo	DoD Directive
Scope	Total Problem Overwhelmingly Complex	Evolutionary Development	Materiel Readiness	Total Force Readiness
Measurement and Analysis	Piecemeal	Multiple Measures and Tools	Use Existing	Develop New
Information Flows	Unorganized/ Inconsistent	Formalization	Organize Existing Information	Formalize Readiness Data Base
Planning/ Coordination	Inadequate Guidance and Organization	Readiness Management Structure	Officially Designated Offices	DoD Directive

The problem of readiness definition requires official recognition of a set of definitions that clearly indicates what is included and what is excluded from the umbrella of "readiness". Eventually, these definitions should be established by DoD Directive and incorporated into JCS Pub 1. A draft Directive for this purpose is included as Appendix A. In the interim period, while problems with specific definitions are worked out, a SecDef memorandum would be sufficient for initiating consistent use of readiness-related terms. A draft SecDef memo is included in Appendix B.

The planning/coordination problem requires the assignment of responsibilities for readiness management to specific offices or individuals in OSD, the Services, and the relevant DoD Agencies (e.g., Defense Logistics Agency). This should also be accomplished, eventually, through a DoD Directive formally

establishing a DoD Readiness Management Program (Appendix A). In the meantime, a SecDef memorandum or a memorandum from the ASD (MRA&L) designating an OSD office as the point of coordination for readiness management would be appropriate. In addition, readiness offices should be designated within each Service. A draft memo for this purpose is also included in Appendix B.

The problems of scope, measurement and analysis, and information flows require that existing sources of information be identified and organized, first for materiel readiness, expanding the scope in future years to total force readiness. The identification of measures, measurement/reporting systems, and models/analytic techniques currently used or under development for resource allocation and policy formulation would highlight deficiencies. These deficiencies would form the substance for the development of a long-range plan for readiness management improvement.

DEVELOPMENT OF A LONG-RANGE PLAN

We propose the structural framework previously discussed as the basis for the development of a long-range plan. This will require, first, the formulation of a force classification scheme. For each force type, measures, reporting systems, and models/analytical techniques currently used (or under development) would then be identified. The results could be organized in a matrix, as in Figure 15. (The abbreviations used in Figure 15 are listed on the following page.) The top portion of the matrix identifies measures of readiness for each force type, and the measurement/reporting systems from which those measures are derived. The lower portion of the matrix identifies models or other methods of analysis used to relate specific resource categories to specific measures of readiness. For example, the Aircraft Availability Model (AAM) is used to relate spares procurement and depot component repair funds to aircraft availability.

FIGURE 15. MATRIX OF MEASUREMENT, REPORTING, AND ANALYSIS METHODS AND SYSTEMS

MILITARY EFFECTIVENESS														
CAPABILITY														
FORCE READINESS														
COMBAT FORCES														
AIR FORCE TACTICAL AIR			NAVAL SURFACE COMBAT			ARMY ARMORED COMBAT			MOBILITY FORCES			C ³ I FACILITIES		
MATERIEL PERSONNEL			MATERIEL PERSONNEL			MATERIEL PERSONNEL			MATERIEL PERSONNEL			MATERIEL PERSONNEL		
UCMS			UCMS			UCMS			UCMS			UCMS		
MICAP			MICAP			MICAP			MICAP			MICAP		
LCMS AFIRMS			LCMS AFIRMS			LCMS AFIRMS			LCMS AFIRMS			LCMS AFIRMS		
SPARES PROCUREMENT			SPARES PROCUREMENT			SPARES PROCUREMENT			SPARES PROCUREMENT			SPARES PROCUREMENT		
DEPOT COMPONENT REPAIR			DEPOT COMPONENT REPAIR			DEPOT COMPONENT REPAIR			DEPOT COMPONENT REPAIR			DEPOT COMPONENT REPAIR		
R & M MODS.			R & M MODS.			R & M MODS.			R & M MODS.			R & M MODS.		
MILITARY MAINTENANCE PERSONNEL			MILITARY MAINTENANCE PERSONNEL			MILITARY MAINTENANCE PERSONNEL			MILITARY MAINTENANCE PERSONNEL			MILITARY MAINTENANCE PERSONNEL		
MUNITIONS PROCUREMENT			MUNITIONS PROCUREMENT			MUNITIONS PROCUREMENT			MUNITIONS PROCUREMENT			MUNITIONS PROCUREMENT		
STOCK FUND			STOCK FUND			STOCK FUND			STOCK FUND			STOCK FUND		
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MEASUREMENT AND REPORTING SYSTEMS

MODELS AND METHODS OF ANALYSIS FOR RELATING RESOURCES TO READINESS

GREEN - IN USE
 BLUE - LIMITED USE
 RED - IN DEVELOPMENT

LIST OF ABBREVIATIONS IN FIGURE 15

AAM	- Aircraft Availability Model
AFIRMS	- Air Force Integrated Readiness Management System
A _O AM	- Operational Availability Allocation Model
AURA	- Armored Unit Readiness Assessor
CASREPT	- Casualty Reporting System
INSURV-MCI	- Board of Inspection and Survey- Materiel Condition Index
LCMS	- Logistics Capability Measurement System
LCOM	- Logistics Composite Model
LIST	- Logistics Investment Screening Technique
LSEE	- Logistics Support Economic Evaluation
MICAP	- Mission Capability Allocation System
MRR	- Materiel Readiness Report
NAVFORSTAT	- Navy Force Status Reporting System
ORCA	- Operational Readiness Criticality Analysis
RIM	- Readiness Indicator Model
SCIR	- Subsystem Capability Impact Report (in use for aircraft; under consideration for ships)
SGM	- Sortie Generation Model
TAC TURNER	- A tactical air base simulation model
TIGER	- A Navy reliability and availability simulation model
UCMS	- Unit Capability Measurement System
USR	- Unit Status Reporting

It is very likely that some resources are currently related to readiness through accounting procedures, simple planning factors, and/or subjective judgment. It is impossible from simply looking at the matrix to determine if a deficiency exists. In some cases, for example, it may be that subjective judgment is the most cost-effective means for assessing a particular resource category. Furthermore, a very sophisticated technique may be used for a certain resource category, but the structure and assumptions of the technique may greatly limit the value of the information produced. Hence, each cell of the matrix needs to be individually evaluated for deficiencies. A tool which can assist in this evaluation would be a diagram of the stocks and flows of materiel and personnel for each force type (see Figure 13, page 6-7). This would provide a way of characterizing the structure and assumptions of the various systems, models, and analytical techniques.

The identification of deficiencies would lead to a long-range plan. The establishment of milestones for eliminating deficiencies would be based on a judgment of where the greatest potential for improvement lies and where the costs of developmental efforts are most likely to pay off. Plans for both materiel readiness and personnel readiness are needed. Eventually, the development of management tools for assisting in the evaluation of total force readiness should be considered. This will require further development of the structural framework and evaluation of supplementary sources of information, e.g., readiness exercises. The identification of reliable sources of information and an appropriate information structure will provide the basis for a readiness management and decision support system.

We believe that with such a system, the DoD will have increased ability to treat readiness in its planning process, and will be in a much stronger position to communicate and justify the resources requested to support its

readiness objectives. Also, it will be able to make more effective use of those resources that are allocated for improving readiness.

APPENDIX A: DRAFT DOD DIRECTIVE

DATE

NUMBER

ASD (MRA&L)

DEPARTMENT OF DEFENSE DIRECTIVE

SUBJECT DoD Readiness Management Program

References:

I. PURPOSE

This Directive establishes the basic policies of a planned program for improvement of Department of Defense management of readiness in general and allocation of readiness-related resources in particular.

II. AUTHORITY

This Directive is issued pursuant to the provisions of Public Law 95-79, Section 812, and related instructions of the President and Office of Management and Budget.

III. APPLICABILITY AND SCOPE

- A. The provisions of this Directive apply to the Office of the Secretary of Defense, the Military Departments, and the Defense Agencies (hereinafter referred to collectively as "DoD Components").
- B. Its provisions encompass all DoD Components having responsibility for allocation of readiness-related resources and for long-range readiness policy in general. This includes all aspects of readiness--force readiness, combat unit readiness, materiel readiness, personnel readiness--as defined in the enclosed glossary.

IV. OBJECTIVES

The overall objective is to improve the capability of the DoD Components in evaluating the impacts of funding levels on military readiness. Specific objectives to be realized in the accomplishment of the Program include:

- A. Standardization of readiness-related terms used in the narrative justification of requested funds during the programming and budgeting process, and in the documentation of study results, models, and other methods of analysis.
- B. Development of appropriate and quantifiable measures of readiness.
- C. Implementation of reporting systems to collect the data necessary to support these measures.
- D. Development of tools to assist in relating resources to readiness.
- E. Provision of mechanisms for managing the application of resources and the execution of policy decisions.
- F. Establishment of a formal management structure within DoD with responsibility for evaluating readiness-related resource allocation decisions and for initiating and coordinating efforts to improve the capability to manage readiness.

V. POLICIES

A. General

- 1. Standardization. Effective resource allocation decisions require that consistent and standardized criteria be used in justifying proposed programs and budgets. The definitions provided in the enclosed glossary will serve as guidance in the use of readiness-related terms.
- 2. Resource Allocation. The complexity and magnitude of the factors involved in the relationships between resources and readiness make it necessary to evaluate resource allocation decisions in terms of individual aspects of readiness--materiel readiness, personnel readiness, etc. However, the importance of placing these narrow evaluations in the overall readiness framework--force readiness, DoD capability, military effectiveness--must be understood.

B. Command and Management

1. DoD Components. Each DoD Component with responsibility for allocation of readiness-related resources will designate an office or offices for evaluating resource allocation decisions which have readiness implications. One individual will be assigned to manage the office or offices and will serve as the primary point of coordination within the DoD Component for the Readiness Management Program. The Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics) will designate an office as the point of coordination for the total program. These readiness offices will have top-level visibility, and will be responsible for issuing guidance through the Consolidated Guidance, directives, instructions, regulations, and memoranda on readiness issues; preparing and evaluating program and budget submissions, and the annual readiness report to Congress; developing and maintaining a long-range plan for improving the capability to manage readiness; and monitoring research sponsored to accomplish the objectives of that plan.
2. Readiness Advisory Board. The Secretary of Defense will appoint individuals to serve on the Readiness Advisory Board. These individuals will include representatives from the DoD Components and the Joint Chiefs of Staff, and other management and technical experts from outside DoD. The latter will be selected primarily from other Federal agencies, academic institutions, and other not-for-profit institutions. The Readiness Advisory Board will meet periodically to review and discuss the state of readiness and readiness management in DoD and will forward advice with respect to specific readiness issues.

C. Management Information

1. Readiness Measures. The evaluation of the quantitative impacts of funding levels on readiness requires that appropriate measures of readiness be identified and used. The complexities of readiness measurement make a combination of measures necessary for most aspects of combat readiness. Different measurement techniques--human judgment, direct observation, and analytical derivation--are required. Emphasis needs to be placed on both responsiveness and sustainability of military forces.
2. Reporting Systems. Reporting systems which can provide information useful to the readiness offices in performing their responsibilities must be identified and developed.

Date
No.

3. Analysis. Models and other analytical tools which can assist in evaluating the impacts of funding levels on readiness must be identified and developed.
 4. Readiness Exercise Results. When appropriate, the documentation of the results of readiness exercises and inspections should be made available to the offices with readiness responsibility.
 5. Readiness Research Results. The results of completed and ongoing research related to readiness and readiness management should be made available to the offices with readiness responsibility.
 6. Organization and Storage. The readiness offices will be responsible for collecting, organizing, and maintaining files of management information. This information will be made available, upon request, to potential users in the DoD Components.
- D. Program and Budget Submissions. The Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics) will, in consultation with the DoD Components and the Readiness Advisory Board, specify the form of information to be submitted as justification for readiness-related program and budget requests.
- E. Annual Readiness Report. The Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics) will, in consultation with the DoD Components and the Readiness Advisory Board, specify the form of information to be submitted for inclusion in the Annual Readiness Report to the House and Senate Armed Services Committees.

VI. IMPLEMENTATION

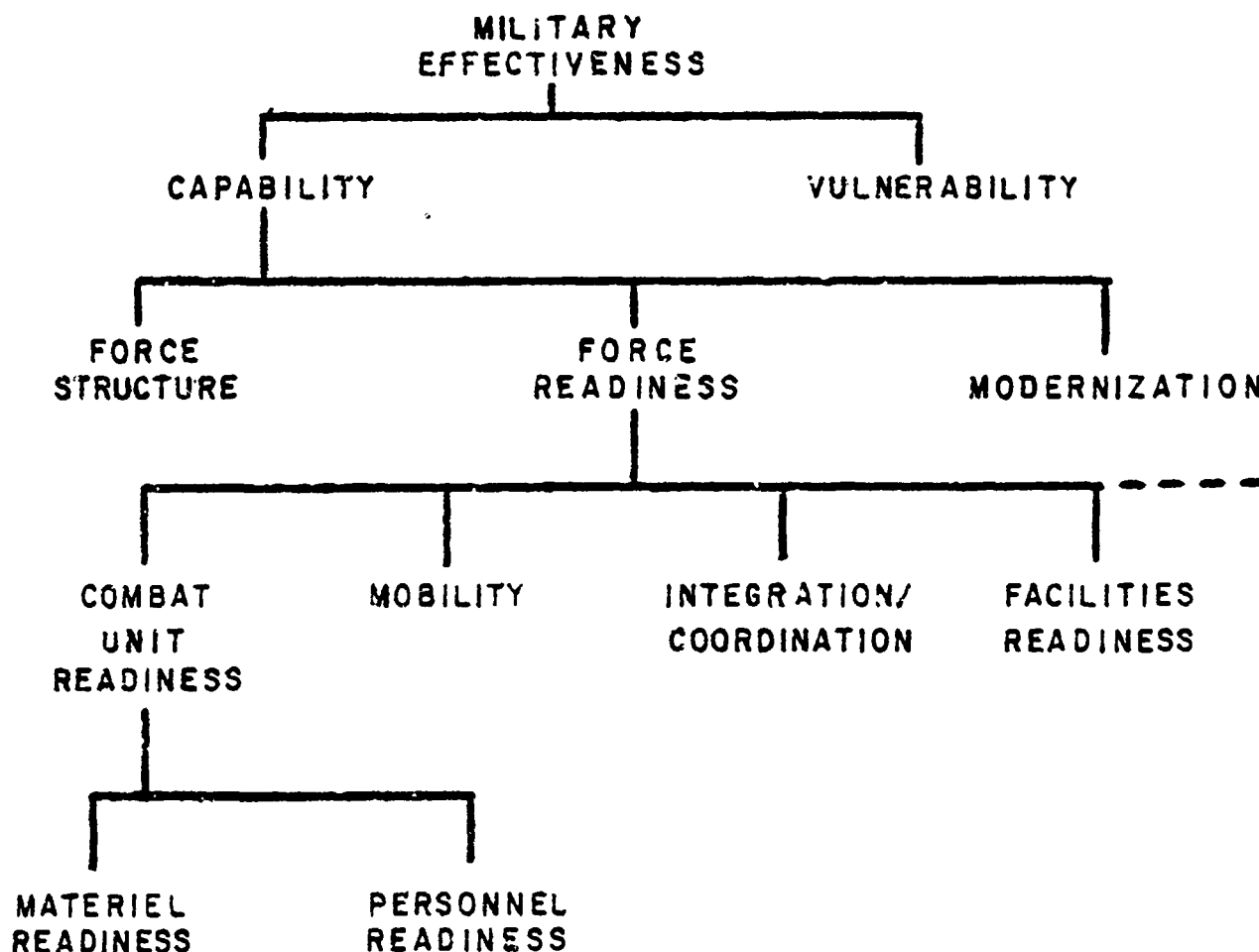
- A. Standardization of Terms The standardized use of readiness-related terms is effective immediately.
- B. Readiness Offices. Readiness offices in the DoD Components should be designated immediately, and the transmittal of the office addresses and the names of office heads to the Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics) will be accomplished within 30 days of this Directive. Any changes should be transmitted to the Assistant Secretary immediately.
- C. Readiness Advisory Board. A search for members of the Readiness Advisory Board should be initiated immediately and completed within 30 days of this Directive. The first meeting of the Board should be convened within 60 days of this Directive.

Enclosures - 1

1. Glossary of Readiness-Related Terms

GLOSSARY OF READINESS - RELATED TERMS

The following definitions are related to readiness through the tree structure shown below.



MILITARY EFFECTIVENESS - The difference between DoD capability and the perceived capabilities of potential enemy threats.

CAPABILITY - The level of successful mission activity possible by DoD forces for given mission and scenario specifications.

VULNERABILITY - The reduction in military effectiveness due to specific weaknesses in DoD forces and military operations for given mission and scenario specifications.

FORCE STRUCTURE - The quantity, mix, and location of military facilities, combat units, weapon systems, equipments, and personnel.

FORCE READINESS - The ability of a force structure, in a given state of modernization, to conduct the military operations expected of it.

MODERNIZATION - The extent to which military weapon systems, equipments, and facilities are not limited by obsolescence or age.

COMBAT UNIT READINESS - The ability of a military combat unit to perform the mission(s) or function(s) that it has been assigned.

MOBILITY - The ability of the DoD to move people, equipment, and supplies from one location to another within specified times.

INTEGRATION/COORDINATION - The ability of command, control, communications, and intelligence activities to support the DoD commands in the conduct of their military operations.

FACILITIES READINESS - The ability of DoD facilities to support military units in the performance of their assigned mission(s) or function(s).

MATERIEL READINESS - The ability of DoD weapon systems and equipments to perform the mission(s) or function(s) for which they are designed or organized.

PERSONNEL READINESS - The ability of DoD personnel to perform the mission(s) or function(s) for which they are trained or organized.

Capability can be alternatively subdivided into responsiveness and sustainability. Hence, readiness also has both responsiveness and sustainability aspects.

RESPONSIVENESS - The capability of military forces, units, weapon systems, equipments, and personnel to initiate military operations within specified times given some warning or mobilization order.

SUSTAINABILITY - The capability of military forces, units, weapon systems, equipments, and personnel to maintain a specified level of wartime mission activity for specified times.

APPENDIX B: DRAFT MEMORANDA

THE SECRETARY OF DEFENSE
Washington, D.C. 20301

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN, JOINT CHIEFS OF STAFF
UNDER SECRETARIES OF DEFENSE
ASSISTANT SECRETARY OF DEFENSE
(COMPTROLLER)
ASSISTANT SECRETARY OF DEFENSE
(MANPOWER, RESERVE AFFAIRS,
AND LOGISTICS)
ASSISTANT SECRETARY OF DEFENSE
(PROGRAM ANALYSIS AND
EVALUATION)
DIRECTOR, NET ASSESSMENT
DIRECTOR, DEFENSE LOGISTICS AGENCY

SUBJECT: Glossary of Readiness-Related Terms

On 2 Nov 1977, I established the DoD Readiness Management Steering Group to oversee the preparation of the first annual readiness report to the Congress and to develop a comprehensive long-range plan to improve the capability of DoD to measure, report, analyze, and manage readiness. While that plan has, as yet, not been completed, numerous efforts are underway to attack various aspects of the problem. Written and oral communications on readiness-related matters, however, indicate that the term "readiness" is used in a wide variety of contexts, resulting in a diversity of meanings. A necessary basis for planning, programming, and reporting on readiness is to have uniform and unambiguous definitions of readiness-related terms.

I am, therefore, establishing the glossary of readiness-related terms enclosed at Tab A as the official definitions to be used for purposes of DoD resource and policy management. The terms are interrelated according to the readiness tree discussed in the introductory comments to the glossary. These definitions are intended to supplement, not replace, those currently used by the Joint Chiefs of Staff in monitoring the immediate status of forces under their authority.

Questions concerning the definitions should be addressed to the Assistant Secretary of Defense (MRA&L), who will be responsible for revising and augmenting the definitions as necessary, subject to my approval. Eventually the glossary will be incorporated into a Directive establishing the DoD Readiness Management Program. In addition, the definitions will be added to the next edition of JCS Pub 1, "Department of Defense Dictionary of Military and Associated Terms."

Secretary of Defense

Attachments

Tab A - Glossary of Readiness-Related Terms

ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
DIRECTOR, DEFENSE LOGISTICS AGENCY

SUBJECT: Designation of Readiness Offices

On 2 Nov 1977, the Secretary of Defense established the Readiness Management Steering Group to oversee the preparation of the first annual readiness report to Congress and the development of a comprehensive long-range plan to improve the capability of DoD to measure, report, analyze, and manage readiness. While that plan has not, as yet, been completed, there are numerous efforts under way which address certain aspects of the problem. However, there is no DoD organizational mechanism for ensuring consistency in these efforts, and for communicating progress which could be useful to all DoD components. Such a mechanism is necessary to formulate and implement a long-range plan, and to develop the capability to meet the reporting requirement established by the Congress in the FY 78 Defense Authorization Act.

I am, therefore, designating the Office of the Deputy Assistant Secretary of Defense (Requirements, Resources and Analysis) as the central point of coordination for formulating and implementing a long-range plan for improving the management of readiness. This does not include the responsibility for monitoring the immediate readiness status of operational units which belongs to the Joint Chiefs of Staff.

In addition to the long-range plan, this office will have responsibility for reviewing the readiness-related portions of the Consolidated Guidance and the Program Objective Memoranda, and for preparing whatever guidance, directives, instructions, issue papers, or memoranda it deems important to the readiness posture of the Defense Department, subject to my approval and that of the Secretary of Defense where appropriate. This office will also sponsor and monitor readiness research efforts, and will serve as a memory bank for information on data, reports, studies, models, and other aspects of management pertinent to the formulation of readiness goals and policies and the allocation of resources to achieve those goals. One of the first tasks of the office, in coordination with representatives of the DoD components, will be to specify the information to be submitted in support of the annual readiness report to Congress.

To ensure that channels of communication for readiness management are available throughout DoD, the Secretaries of the Military Departments and the Director of the Defense Logistics Agency should designate a point of coordination within each Service component or agency. Eventually, these points of coordination will be formally established by DoD Directive.

The designation of organizational responsibility for a DoD Readiness Management Program is an essential step in improving the Department's capability to relate resource inputs to resulting readiness.

Assistant Secretary of Defense
(Manpower, Reserve Affairs and Logistics)

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report describes a concept for readiness management in the DoD that focuses on broad policy formulation and resource allocation. The concept includes a readiness taxonomy; a readiness management structure; guidance for readiness measurement, reporting, and analysis; suggestions for the formalization of information flows; and a framework for evaluating policy and resource allocation decisions. Examples of F-4 materiel readiness and logistics support resources are used to illustrate the concept. Both short-term and		

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long-term implementing actions are recommended.

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